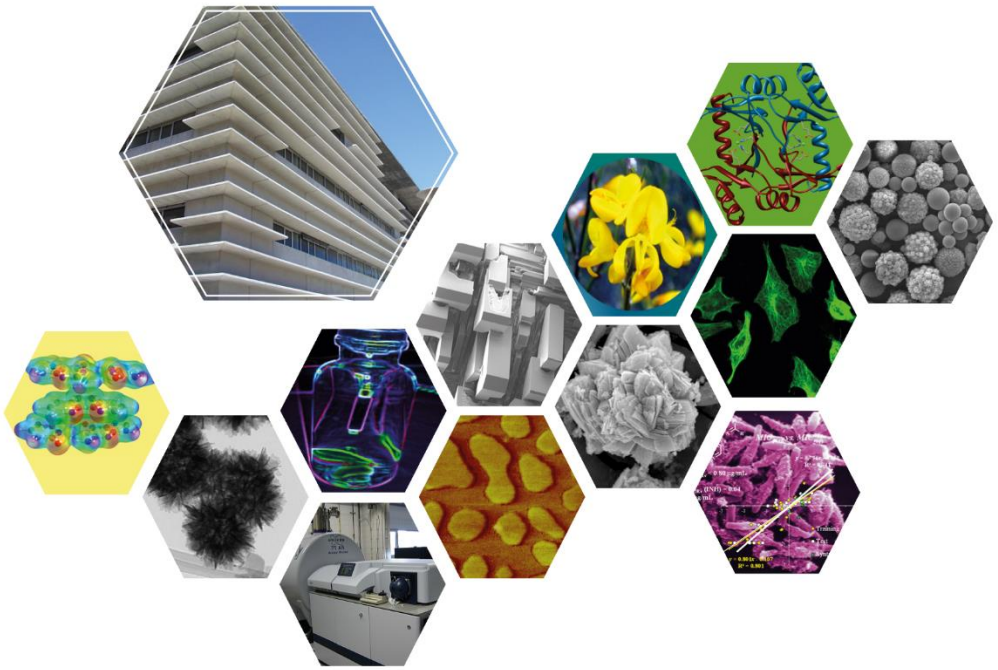
CQB-day 2016

June 28th



Book of Abstracts

Ciências ULisboa | CQB Centro de Química e Bioquímica

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

CQB-Day 2016

June 28th

Faculdade de Ciências – Universidade de Lisboa

ORGANISING COMMITTEE

ANA PAULA CARVALHO
OLINDA C. MONTEIRO
ANA MOURATO

WELCOME TO CQB-DAY 2016

Centro de Química e Bioquímica (CQB) celebrates 15 years since its foundation in 2001, with the aim of creating an environment oriented toward fruitful collaborations between chemistry and biochemistry groups.

The Strategic Project for 2015-2020 (PEst 2015-2020), defined in 2014, and approved by FCT, should strengthen the links between groups around two thematic lines, reflecting the interest and expertise of CQB:

1. *Chemistry and biochemistry for a clean environment*.
2. *Healthy life: molecular interventions and regulation mechanisms*.

During the last CQB-Day, in September 2015, all the groups had the opportunity to present their contributions towards these topics, either orally (selected contributions highlighting collaborative work within the thematic line) or as a poster. Half-way through 2016 and with the triennium evaluation planned by FCT at national level for the second half of 2017, we propose to carry out an internal mid-term evaluation to check our progress in achieving the project goals.

The program of CQB Day 2016 will open with a brief historical account of CQB, by its first coordinator, José Artur Martinho Simões. Lectures will follow, addressing the work of the two thematic lines and the contribution of the science manager, as well as new projects funded and opportunities for the future. A large number (around 80) of poster presentations will contribute to give a general idea of the wealth of ongoing projects and to increase the degree of cross-fertilization between the twelve groups, their members and collaborators. Two members of the External Advisory Committee (Sir William Wakeham and Hans Peter Wessel) will be present and will help us in the self-evaluation exercise. A round table will be dedicated to discuss CQB Activity and Future.

We count on all of you to make this CQB Day very successful and use this unique opportunity to discuss the implementation and progress of our Strategic Project, to strengthen collaborations between groups supported by novel scientific synergies, to find new common grounds for research and grasp the most advantageous funding opportunities.

Maria José Calhorda
CQB coordinator

SCIENTIFIC PROGRAM

9.30h CQB: 15 years and beyond

Martinho Simões
Maria José Calhorda

10.00h Science at CQB - Oral Communications

O1. *Chemistry and Biochemistry for a Clean Environment*
Carla D. Nunes

O2. *"Healthy Life": Interaction of Polyphenols with Lipid Bilayers and their Effects in Human Cells*
Hugo A. L. Filipe, Catarina Peneda, Joaquim T. Marquês, Miguel Machuqueiro, João C. Ramos, Maria da Soledade Santos, H. Susana Marinho, Ana S. Viana, Helena Soares, Rodrigo F. M. de Almeida

O3. *S&T Management at CQB*
Ana Mourato

10.45h Science at CQB – Poster Communications & Coffee Break

11.30h Science at CQB - Oral Communications

O4. *Exploring the Catalytic Behaviour of Hierarchical Mcm-22 Zeolite in Low Temperature Friedel-Crafts Acylation of Heteroaromatics*
Nelson Nunes, Rodrigo Aleixo, Ruben Elvas-Leitão, Filomena Martins, Ana P. Carvalho, Amadeu Brigas, Angela Martins

O5. *New Insights on the Immobilization Mechanism of Escherichia Coli Onto Activated Carbon*s
Susana Marques, Marta Pacheco, Jossano Marcuzzo, Ana S. Mestre, Ricardo Dias, Ana P. Carvalho

O6. *$CoFe_2O_4$ Nanoparticles Synthesized with Natural Templates for Magnetic Hyperthermia*
Liliana P. Ferreira, Maria Margarida Cruz, Maria L. Oliveira, Sofia G. Mendo, André F. Alves, Maria Helena Mendonça, Margarida Godinho, Maria Deus Carvalho

O7. *Herbal Infusions in Age-Related Diseases*
Pedro Luis Falé, Rita Pacheco, Maria Helena Florêncio, Maria Luisa Serralheiro

12.30h – 14.30h Lunch & Science at CQB – Poster Communications

14.30h CQB Scientific Activity and Future

Chairperson: Martinho Simões

Miguel Castanho, Fundação para a Ciência e Tecnologia

Hans Peter Wessel, Universidade de Aveiro

Sir William Wakeham, University of Southampton

15.30h FCT Funded Projects Launched in 2016

Flexible Biomimetic/Nanoconjugated Platforms for Sensitive Immunosensing
Ana S. Viana

CpHMD-L Simulations of Phlip Peptides: Design of New Tumor-Targeted Drug Delivery Systems
Diogo Vila-Viçosa, Pedro Reis, Vitor H. Teixeira, Maria J. Calhorda, António M. Baptista, Miguel Machuqueiro

Multifunctional Luminescent Spin Labile Hybrid Materials
Paulo N. Martinho, Liliana P. Ferreira, Maria de Deus Carvalho, Sara Realista, Nuno A. G. Bandeira,d, Janaína C. Almeida, Frederico F. Martins, Maria José Calhorda

Sphingolipid Organization in the Plasma Membrane of Saccharomyces Cerevisiae
Rodrigo F. M. de Almeida

16.10h Science at CQB - Oral Communications

O8. *New Generation of Microextraction Devices for Trace Analysis Based on Floating Sampling Technology*
Alessandra H. Ide, Alexandra M. Fernandes, André M. Segurado, Samir M. Ahmad, Nuno R. Neng, José M. F. Nogueira

O9. *Unraveling The Role Of Tbccd1 Protein On Cell Size Control: The Regulation Of Cytoskeleton Dynamics And Cell Junctions*
Carolina Camelo, Catarina Peneda, Étienne Coyaud, Brian Raught, Ana I. Câmara, Bruno Carmona, Francisco Pinto, H. Susana Marinho, Helena Soares

O10. *Exploratory Chemistry of Butyrylcholinesterase Nucleoside-Based Inhibitors*
Vasco Cachatra, Ignazio Schino, Nicola Colabufo, Amélia P. Rauter

17.00h Closing Session

Maria José Calhorda

17.20h Happy Hour

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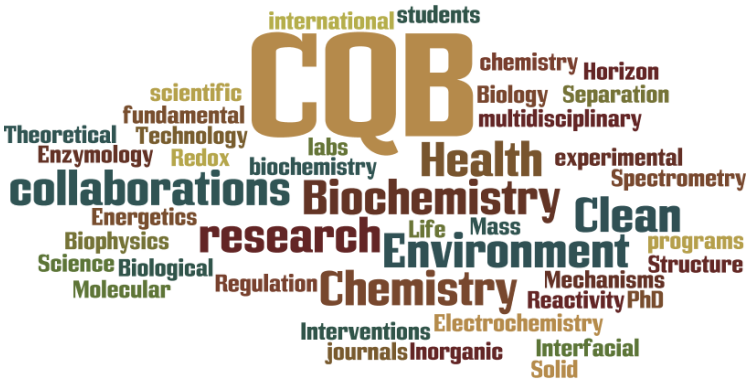
ORAL COMMUNICATIONS

FCT FUNDED PROJECTS LAUNCHED IN 2016

POSTER COMMUNICATIONS



Science at CQB

Oral Communications

Chemistry and biochemistry for a clean environment

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This thematic line was defined taking into account the expertise of the groups and the added value obtained by a closer collaboration between them, aiming at warranting a clean environment. The synthetic skills of several groups provide the conditions to develop new molecules and materials, ranging from organic to inorganic. Heterogeneous catalysts have been designed and built from bulk oxides, nanoparticles and carbon based materials, to be applied as supports (passive) or catalysts (active). Particular attention was paid to low-cost raw materials. Such combined approaches led to applications in asymmetric and photo-catalysis; capture and reduction of CO_2, photodegradation of new generation pollutants, namely carbamazepine and ibuprofen (drugs), and clofibric acid (pesticide), which have been selected as representative examples of their classes. They represent a major concern owing to the continuously increasing consumption of medicinal drugs and crop protection agents worldwide.

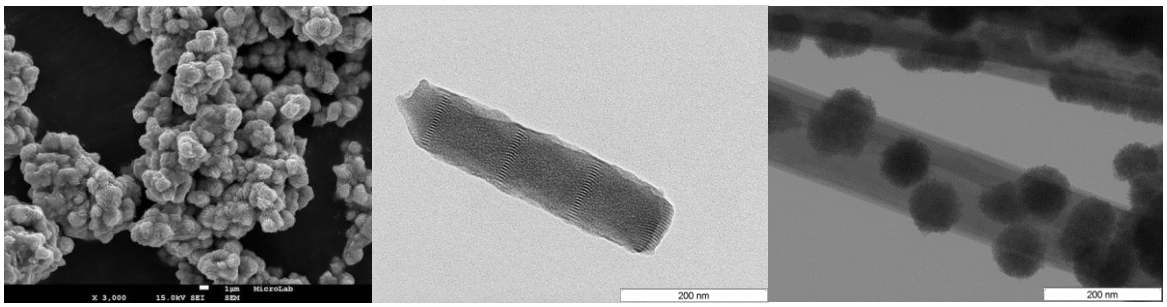

Figure 1: Examples of materials used in the described applications

New analytical methodologies are being developed for the detection of emerging contaminants in water resources as well as for their reduction/removal. Selection of this matrix is of utmost relevance, since water is a valuable commodity for any population and ecosystem on Earth. The developed methodologies comprised separation methods for the analysis of priority organic species, including the design, validation and application of innovative and alternative analytical approaches.

Here they will be present the achievements, contributions the last developments in this thematic line from the CQB research groups.

Acknowledgements
The authors thank FCT for financial support (UID/MULTI/00612/2013).

A.S. Mestre, A. Nabiço, P.L. Figueiredo, M.L. Pinto, M.S.C.S. Santos, I.M. Fonseca, Chem. Eng. J. 2016, 286, 538–554.
G. Naudin, T. Entradas, B. Barrocas, O.C. Monteiro, J. Mat. Sci. Tech., 2016 in press.
M.K.S. Batista, A. S. Mestre, I. Matos, I. M. Fonseca, A. P. Carvalho RSC Advances, 2016, 6, 45419-45427.
Y. Tokudome, T. Morimoto T., N. Tarutani, P.D. Vaz, C.D. Nunes, V. Prevot, G. Stenning, M. Takahashia, ACS Nano, 2016, 10, 5550–5559.
B. Barrocas, S. Serio, A. Rovisco, Y. Nunes, M.E.M. Jorge, Appl. Surf. Sci., 2016, 360, 798-806.
O. Ortet, M.S.C.S. Santos, A.P. Paiva Sep. Sci. Technol., 2016 (in press).
F.N. Andrade, A.H. Ide, N.R. Neng, F.M. Lanças, J.M. Nogueira, J. Sep. Sci., 2016, 39(4), 756-761.

"Healthy Life": Interaction of polyphenols with lipid bilayers and their effects in human cells

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This work concerns the transversal project of the CQB thematic line: "Healthy Life: Molecular Interventions and Regulation Mechanisms".

Biologically active plant phytochemicals have a broad range of pharmacological effects including anticarcinogenic, antimicrobial, antioxidant, and anti-inflammatory activity. [1] Notwithstanding the possibility of having a specific target, phytochemicals must interact and permeate through cell membranes in the body. Indeed, it was suggested that those molecules insert into the membranes and thereby may have a promiscuous activity by changing structural properties of lipid bilayers. [2]

Some well-known phenolic acids such as caffeic (CA), rosmarinic (RA) and chlorogenic (CGA) acids, whose identification in plant extracts has been achieved by CQB research groups, were selected to be addressed in first place (Figure 1).

All the phenolic acids studied have low lipophilicity and among them, RA was the only one with a partition to biological membrane models measurable by fluorescence spectroscopy, as opposed to CA and CGA. Cyclic voltammetry measurements using an electrode modified with a supported lipid bilayer also indicated a higher affinity of RA to lipid membranes. In addition, oxidation/reduction of the phenolic acids displayed higher reversibility in the lipid milieu than in the aqueous bulk. Indeed, the reduced form of phenolic acids was unstable in aqueous solution. In particular, in DMEM/F-12 cell culture media, a colour change observed after incubation with each compound could be reverted by the addition of a reducing agent. The higher reversibility of phenolic acids oxidation/reduction, once they were inserted in the lipid membrane, may contribute to the stability of the compounds and prevent the formation of degradation products. Molecular dynamics (MD) simulations are being performed to probe the location and orientation of these and other selected compounds in lipid bilayers.

The influence of the phenolic acids in the cytoskeleton organization, both actin filaments and microtubules, of a human retinal pigment epithelial cell line (RPE1) was also investigated. All compounds induced concentration and time dependent effects, translated in structural alterations mainly at the cell periphery, and also in the perturbation of cell division. Moreover, it was not evident that these compounds induce apoptosis under the conditions tested. RA seemed to induce evident effects at earlier times and at lower concentrations, as compared to CA and CGA. This higher sensibility of RPE1 cells to RA correlates with the higher affinity of this compound to the lipid bilayer.

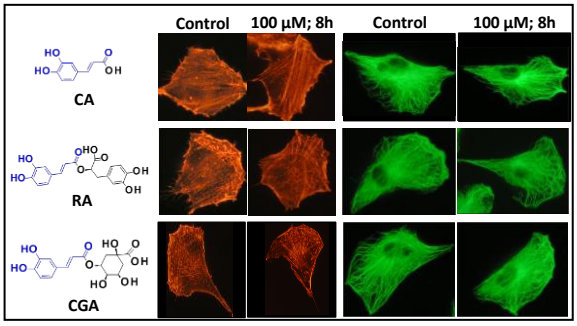


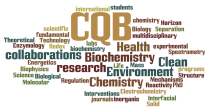
Figure 1. Effects in the actin filaments (red) and microtubules (green) of RPE1 cells, after 8 h incubation with 100 µM of phenolic acid.

Acknowledgements

Support for this work was provided by F.C.T. through IF2012/2013 initiatives (P.O.P.H., F.S.E.) and Project UID/MULTI/00612/2013. H.A.L.F. acknowledges post-doc fellowship under the same Project. M.L. Serralheiro is acknowledged for the phenolic acids.

[1] A. Stefanson and M. Bakovic, Nutrients 6 (2014) 3777-3801.

[2] H. I. Ingólfsson, P. Thakur, K. F. Herold, E. A. Hobart, N. B. Ramsey, X. Periole, D. H. de Jong, M. Zwama, D. Yilmaz, K. Hall, T. Maretzky, H. C. Hemmings, C. Blobel, S. J. Marrink, A. Koçer, J. T. Sack and O. S. Andersen, ACS Chem. Biol. 9 (2014) 1788-1798.



S&T Management at CQB

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A manager in Science and Technology of a research unit is usually working simultaneously at multiple interfaces and needs to establish the necessary bridges between researchers & unit coordination, researchers & society and researchers & institutions. In the Research Units, all researcher have their own ideas of what should be the functions of a manager in Science and Technology. The most common are gathering information on funding opportunities, write projects, communicate science, write press releases, manage and organize data, support the unit coordination, promote and organize events, etc. But, which of them are the most important, relevant and decisive for a Research Unit? Many are realistic, others less and, therefore, to help clarify and understand the expectations of scientists regarding this theme, a multiple-choice survey was created and distributed to all CQB members. This survey aimed to enhance and manage more effectively the interaction between researchers and Manager of Science and Technology. The information collected was also used to compare the chosen tasks with those already performed by the science manager of CQB. With this knowledge, we were able to evaluate how researchers expectations align or diverge from the work plan developed by the Science manager.

Acknowledgements
Support for this work was provided by Fundação para a Ciência e Tecnologia (FCT), Portugal, through projects UID/MULTI/00612.

Exploring the catalytic behaviour of hierarchical MCM-22 zeolite in low temperature Friedel-Crafts acylation of heteroaromatics

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MCM-22 is a synthetic zeolite (Mobil 1990) with a peculiar structure, presenting three independent pore systems, two of them internal and the last one located at the external surface of the crystals. Even though this structure presents internal supercages, with a high concentration of acidic active sites, they are only accessed through narrow windows. Thus, the modification of the textural properties of this zeolite, through the creation of a micro + mesopore hierarchical structure, allows the improvement of molecular diffusion and access to the active sites, especially when larger molecules are involved. In this study hierarchical MCM-22 was prepared by performing post-synthesis basic or a combination of basic + acid treatments. The experimental procedures as well as the discussion of structural, textural and acidic characterization are reported elsewhere [1]. Friedel-Crafts acylation of heteroaromatics is an important industrial reaction that traditionally uses homogenous catalysts, such as $AlCl_3$ and $FeCl_3$ that are harmful to the environment. The use of commercial zeolites as environmentally friendly catalysts has been reported [2], however, the use of hierarchical zeolites, and especially hierarchical MCM-22, has never been explored. In this study the catalytic behaviour was investigated in the acylation of simple heteroaromatics such as furan, anisole or pyrrole, by acetic anhydride (Figure 1) using a molar ratio of 1:5 and 150 mg of zeolite, at 60 ºC. Samples of the reaction mixture were analysed periodically by GC to follow conversion and yields as a function of time. Langmuir-Hinshelwood model was used to calculate kinetic parameters as well as turnover frequencies (TOF). The analysis of the results shows an improved catalytic behaviour for hierarchical MCM-22 modified through alkaline + acid treatment when compared to parent MCM-22, presenting enhanced mass transport and access to the active sites, making hierarchical MCM-22 a promising catalyst for Friedel–Crafts acylation of larger heteroaromatic molecules.

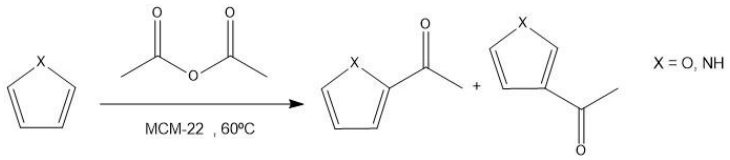

Figure 1. General scheme for the acylation of heteroaromatic compounds.

Acknowledgements

Support for this work was provided by FCT through UID/MULTI/00612/2013 and PEst-OE/QUI/UI0612/2013.

[1] V. Machado, J. Rocha, A. P. Carvalho, A. Martins, App. Catal. A: Gen. 329 (2012) 445-446.

[2] V.F.D. Álvaro, A.F. Brigas, E.G. Derouane, J.P. Lourenço, B.S. Santos, J. Molecular. Catalysis A: Chemical 305 (2009) 100-103.

New insights on the immobilization mechanism of *Escherichia coli* onto activated carbons

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Adsorption on activated carbons is a well-established method used in water treatment to remove numerous pollutants. Microorganisms present in water can become immobilized in the adsorbent, possibly affecting the adsorption process. As new forms of adsorbents are developed, it is important to understand the impact of these materials' properties in the mechanism of bacteria immobilization, to conclude about the possible advantages of using these new materials in water treatment purposes.

In this work, the influence of the adsorbent morphology (granular, powder and cloth), texture and superficial chemistry in the immobilization of *E. coli* cells in aqueous media was investigated.

The results indicate that favorable electrostatic interactions carbon surface-cells is a key factor in bacteria immobilization by activated carbons that must be complemented by its morphology and textural characteristics. Thus using basic carbons, electron microscopy results revealed that powder morphology allows the formation of agglomerates carbon-cell-cell-carbon. In the case of granular and cloth samples the data already obtained suggest that, in an initial stage, individual cells adhere to the external surface of the carbon particles (more efficiently in cloth morphology). Further assays, considering different cellular densities and the simultaneous presence of pharmaceutical compounds in the aqueous medium are being performed.

Acknowledgements

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REFERENCES

[1] T.J. Bandosz in: T.J. Bandosz (Eds.), Activated carbon surfaces in environmental remediation, New York, 2006, pp. 159-230.
[2] A.L. Cukierman, ISRN Chem Eng (2013) (DOI: 10.1155/2013/261523)
[3] A.M. Paruch, Water Sci Technol. 63 (2011) 558-564.
[4] F. Veglio, F. Beolchini, *Hydrometallurgy* 44 (1997) 301-316.
[5] X. Bai, X. Ma, F. Xu, J. Li, H. Zhang, X. Xiao, Sci Total Environ 533 (2015) 24-31.
[6] J. Rivera-Utrilla, I. Toledo, M.A. Ferro-García, C. Moreno-Castilla, J Chem Technol Biotechnol 76 (2001) 1209-1215.
[7] S.C. Edberg, E.W. Rice, R.J. Karlin, M.J. Allen, J Appl Microbiol. 88(S1) (2000) 106-116.
[8] H.P. Boehm, Carbon 32(5) (1994) 759-769.
[9] A.S. Mestre, J. Pires, J.M.F. Nogueira, A.P. Carvalho, Carbon 45 (2007) 1979-1988.
[10] K.S.W. Sing, Pro. Int Symp., 1970.

$CoFe_2O_4$ nanoparticles synthesized with natural templates for magnetic hyperthermia

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Magnetic nanostructured materials have a wide range of applications in nanodevices magnetic information storage media, and biomedical applications like drug delivery, resonance imaging (MRI) and magnetic hyperthermia. This latter technique uses magnetic nanoparticles under an alternating magnetic field as local heat dissipating agents for cancer therapy [1]. Besides magnetite (Fe_3O_4), other ferrites such as $CoFe_2O_4$ have been also investigated for such applications. Cobalt ferrite is ferrimagnetic with a high saturation magnetization and uniaxial magnetic anisotropy. These properties make $CoFe_2O_4$ nanoparticles (NP) good candidates for magnetic hyperthermia since anisotropic magnetic NP are expected to be associated with high heating efficiency.

Aiming at controlling the nanoparticles size and morphology, new synthesis methods have been explored in order to enhance their magnetic properties, namely the magnetic anisotropy. In this work, the synthesis of $CoFe_2O_4$ was performed in the presence of natural fibers, following an established methodology [2], resulting in two batches of samples: the first one are nanoparticles obtained directly from the solution, and the second one are the nanoparticles resulting from the template calcination. The structural, morphological and magnetic characterization of these particles was performed using several techniques. Their potential for magnetic hyperthermia was assessed through induction heating measurements under an alternating magnetic field and evaluated through the specific loss power (SLP) parameter using the methodology and the experimental set-up previously described in detail [3].

The NP obtained after the templates calcination show morphologies that are determined by the threaded templates, leading to magnetic coercivity values strongly enhanced when compared with other NP obtained by conventional methods. The coercive fields reach values of 1.3 T at 10 K, decreasing to 70 mT at room temperature, values comparable to the ones obtained in $CoFe_2O_4$ nanofibers or nanorods (Figure 1). Concerning the magnetic hyperthermia results, it was shown that for nanoparticles obtained from the solution, SLP values of ~ 7 W g^{-1} were obtained for dispersions in water and were mainly attributed to Brown relaxation due to a high surface contribution to the magnetic anisotropy constant. These values decrease for the nanoparticles obtained after template calcination, showing that higher magnetic anisotropy does not necessarily imply higher heating efficiency and that the optimization of the NP heating performance by tailoring the NP morphology requires a careful balance between size and shape.

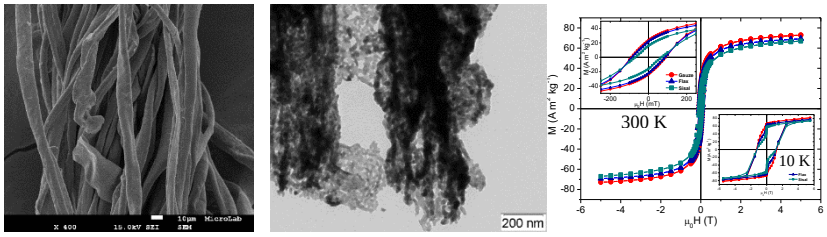

Figure 1. SEM image of gauze (left); TEM image of $CoFe_2O_4$ nanoparticles obtained after gauze calcination (middle); magnetization results of all samples obtained after template calcination (right).

Acknowledgements

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[1] A. Jordan, P. Wust, R. Scholz, H. Faehling, J. Krause, R. Felix, Magnetic fluid hyperthermia, In *Scientific and Clinical Applications of Magnetic Carriers;* ed. U. Häfeli, W. Schütt, J. Teller and M. Zborowski, Plenum Press, New York, 1997.
[2] S. G. Mendo, A.F. Alves, L .P. Ferreira, M. M. Cruz, M.H. Mendonça, M. Godinho, M. D. Carvalho, New J. Chem., 39, (2015) 7182-7193.
[3] A. F. Alves, S. G. Mendo, L. P. Ferreira, M. H. Mendonça, P. Ferreira, M. Godinho, M. M. Cruz, M. D. Carvalho, J. Nanopart Res. 18 (2016) 27 (13 pag).

Herbal infusions in age-related diseases

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The aim of the group is to study the effect of plant infusions and their components (Fig.1) in the prevention and treatment of age-related diseases such as Alzheimer disease (AD), atherosclerosis and cancer. Plant aqueous extracts have been used throughout history for their medicinal[1] and health-promoting properties. Scientific studies have related these therapeutic properties with several molecular mechanisms on which the phenolic components of plant extracts have shown some activity. Age-related diseases are multifactorial-caused and also require treatments using multiple approaches. The main approaches selected are the inhibition of enzymatic activities involved in AD (acetylcholinesterase)[2],hyper-cholesterolemia (HMG-co reductase[3] and cholesterol transporter proteins[4]). The effect of bioactive molecules for cancer treatment is also an objective of the group, focusing on the expression of proteins and on metabolomics. A relationship between bioactivity and chemical constitution of the plant extracts has been established for several plant extracts. The chemical constituents have been identified by means of mass spectrometry and mass spectrometry- hyphenated techniques. Additionally, the group has also been involved in the production of protein-based nanoparticles to encapsulate bioactive phenolic compounds and to study the permeability through Caco-2 monolayers as models of the intestinal barrier. This work allowed the group to present 8 posters all having the same objective, that is, to study the bioactivity of phenolic compounds either from infusions or from leaves of plants or even recovering them from peels of fruits. These studies allowed to establish collaborations between CQB groups, such as the Interfacial Electrochemistry Group for AFM studies of nanoparticles and cell image, and the Inorganic and Theoretical Chemistry Group for docking studies of phenolic compounds with AChE. The group also studies the effect of phenolics on protein secondary structure (FT-IR) in collaboration with DMU, Leicester, UK, and the effect of drugs on living cells using FT-IR (ATR), in collaboration with King's College London, UK.

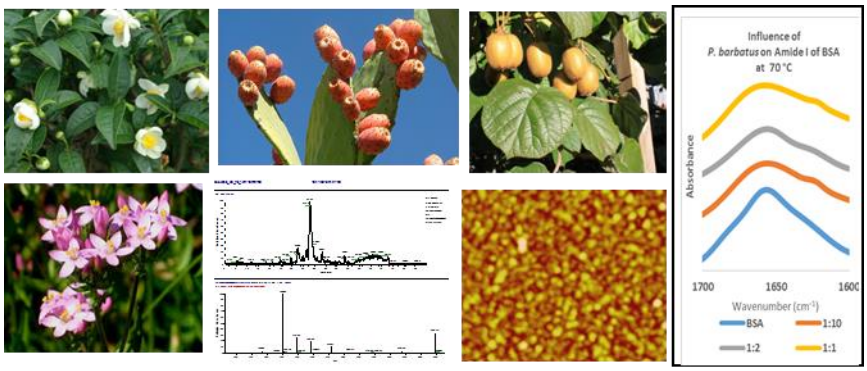

Figure 1: Example of herbs, LC-MS/MS, FTIR of proteins and protein-based nanoparticles

In the near future the group will focus on the effect of active compounds, drugs and natural products, in cancer mechanisms using mass spectrometry and mass spectrometry hyphenated techniques as well as FT-IR applied to living cells; on mechanisms of hypercholesterolemia and atherosclerosis treatments; on protein aggregation, associated with several age-related diseases; on new models to test new treatments, closer to the living organism (such as 3D cell culture); and also on the development of new methodologies for studying antioxidant and anti-inflammatory activities using cells *in situ*.

Acknowledgements
FCT for the programmatic financing reference number: UID/MULTI/00612/2013.

[1] A. Proença-da-Cunha, A.P. Silva, O.R. Roque. Plantas medicinais em fitoterapia. Fundação Calouste Gulbenkian, Portugal, Lisboa, 2003.
[2] M. Heinrich, H.LTeoh, J. Ethnopharmacol. 92 (2004) 147-162.
[3] D. Iqbal, M.S. Khan, S. Ahmad, A.K.Srivastava, Phytother. Res. 28 (2014) 899-908.
[4] D. Feng, L. Ohlsson, R.D. Duan, Lipids Health Dis. 9 (2010)40

New generation of microextraction devices for trace analysis based on floating sampling technology

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In the analysis of complex matrices, sample preparation is the most time consuming step. For this reason, the modern sample preparation approaches aim the miniaturization of the analytical devices and easy manipulation, as well as reduced sample volumes and absence (*i.e.* solventless) of toxic organic solvents in compliance with the green analytical chemistry principles.

"Bar adsorptive microextraction" (BAμE) is a novel technique introduced by our group, which uses an approach based on the static mode and operates under the floating sampling technology. This novel technique uses an analytical device, light in weight in comparison to water density, simultaneously with a conventional Teflon magnetic stirring bar at the bottom of the sampling flask. When the sample matrix is rapidly spinning around due to centripetal force promoted by the magnetic bar, the analytical device stays under free-floating motion just below the centre of the formed vortex. Several coating phases have also been applied by this technique, including many types of activated carbons, polymers, ionic liquids, etc., in particular for trace analysis of the more polar compounds in aqueous media.

During a static process, the analytes migrate by diffusion from the sample bulk and are retained in a convenient sorbent phase, where the microextraction takes place. Then, the devices are removed from the samples, transferred into vials containing inserts with the stripping solvent, where the back-extraction stage takes place under sonication. Subsequently, the devices are removed from the inserts and, after evaporation and solvent-switch, the microextracts become ready for instrumental analysis.

Recently, our group have been involved on reducing the number of analytical steps required for the back-extraction stage. For this purpose, new generation BAμE devices, smaller and more flexible than the original ones have been developed. The extraction and back-extraction stages still remain similar to the methodology described before, although the latter being performed in only-one liquid desorption step.

Another type of analytical devices proposed uses porous hollow fibres or polyurethane polymers, both having cylindrical geometry, in which are dipped with appropriate organic solvent for the microextraction of many classes of non-polar compounds in aqueous media.

By using these analytical approaches, trace analysis can be performed in matrices from several scientific areas, such as environment (pharmaceutical and personal care products, pesticides, endocrine disruptors, etc.), forensic (drugs of abuse, legal highs, steroid hormones, etc.), food (disinfection by-products of water, flavonoids, polyphenols, etc.) and many others.

Acknowledgements

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Unraveling the role of TBCCD1 protein on cell size control: the regulation of cytoskeleton dynamics and cell junctions

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During their lifetime most cells maintain their size. There is increasing evidence showing that this process may be dynamic and that cells can adapt their size in response to external signals and changes in the environment [1], which strongly suggests that cell size is regulated. Both Hippo and IGF/PI3K/AKT/mTORC1 pathways have been described as being involved in cell size/growth control [1]. Interestingly, these pathways are in a cross-talk with others involved and/or dependent on cellular polarity [2]. Our group characterized a centrosomal protein, TBCCD1 (TBCC domain-containing human protein 1) which, when depleted in human retinal epithelial (RPE-1) cells, leads to an abnormal localization of the centrosome at the cell periphery accompanied by the fragmentation of the Golgi apparatus, resulting in the disruption of the intrinsic cell polarity axis "Nucleus-Centrosome-Golgi Apparatus". Moreover, TBCCD1-depleted cells are larger, slower and have a lower efficiency in primary cilia assembly than control cells [3]. We identified the TBCCD1 interactome that showed that most of its partners are involved in cell polarity. Furthermore, most of them participate in the formation/maintenance of cell junctions, which are main regulators of cell polarity in epithelia and are upstream of pathways, like Hippo pathway. We also observed that TBCCD1 overexpression affects tubulin acetylation, which supports our results showing that some of the partners are involved in the regulation of the cytoskeleton dynamics, which may affect cell size. Therefore, it is tempting to hypothesize that the mechanisms involved in the establishment of intrinsic cell polarity may also directly/indirectly participate in the regulation of cell size.

Acknowledgements
Support for this work was provided by CQB`s PEST UID/MULTI/00612/2013.

[1] Lloyd AC. The regulation of cell size. Cell. 2013 Sep 12; 154(6):1194-205.
[2] Soares H, Marinho HS, Real C, Antunes F. Cellular polarity in aging: role of redox regulation and nutrition. Genes Nutr. 2014 Jan;9(1):371.
[3] Gonçalves J, Nolasco S, Nascimento R, Lopez Fanarraga M, Zabala JC, Soares H. TBCCD1, a new centrosomal protein, is required for centrosome and Golgi apparatus positioning. EMBO Rep. 2010 Mar;11(3):194-200.

Exploratory chemistry of butyrylcholinesterase nucleoside-based inhibitors

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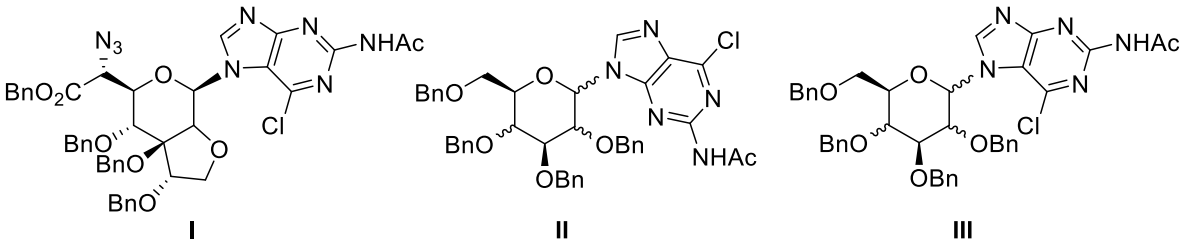
The increase in average life expectancy raises a number of challenges resulting in the development of new strategies pointing to a healthy ageing. As our organism begins to age, dementia is one of the many hurdles to overcome affecting 46.8 million people worldwide, with recent trends showing an increase in this number for the coming years.[1] Alzheimer`s disease (AD) is the most common type of dementia but the complete disease ethiology is not known. While current treatments are based on the inhibition of acetylcholinesterase (AChE) or dual inhibition of AChE and butyrylcholinesterase (BChE) to restore acetylcholine levels on the brain, this effect is only signficant in the early disease stages. BChE takes the role of AChE in hydrolysing acetylcholine in later stages,[2] so the search for selective inhibitors of BChE has the possibility to provide better treatment options and/or to have new insights onto AD ethiology.

Our research group has developed a new family of nucleosides that demonstrated a potent and selective inhibition of BChE.[3] They have key structural features, namely a 2-acetamido-6-chloropurine N-linked to an unusual bicyclic sugar moiety (type I), or linked to glycosyl residues as depicted in structure-types II and III. Optimization of synthetic procedures for regio- and stereoselectivity toward potent activity and selectivity, synthesis of analogues and computational studies have been carried out to understand the binding mode and identify the key structural features required for the activity. These results will be disclosed and discussed.



Acknowledgements

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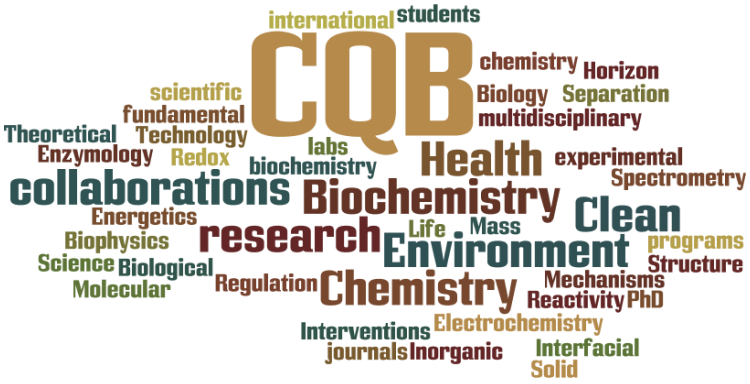
[1] Alzheimer`s Disease International *World Alzheimer`s report* **2015,** 1;

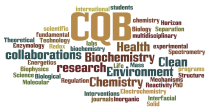
[2] I. R. Macdonald, K. Rockwood, E. Martin, S. Darvesh *J. Alzheimers Dis.* **2014,** *42*, 379;

[3] a) F. Marcelo, F. M. V. Silva, M. Goulart, J. Justino, P. Sinaÿ, Y. Blériot, A. P. Rauter, *Bioorg. Med. Chem.* **2009,** *17(14)* 5106; b) S. Schwarz, R. Csuk, A. P. Rauter, *Org. Biomol. Chem.* **2014,** *12*, 2446.



Science at CQB

FCT Funded Projects Launched in 2016



CQB-Day 2016

Flexible biomimetic/nanoconjugated platforms for sensitive immunosensing

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The major scientific goal of this work is to develop simple and disruptive surface chemistry to push forward the field of biosensing. The preparation of biosensors, as the sandwich-type immunosensors, with improved sensitivity regarding expensive enzyme immunoassays (Enzyme linked immunosorbent assay, ELISA) [1], can follow two main strategies. One is to increase the capture of antigen by the primary antibody adsorbed on the surface (recognition layer), and the other is to optimize the signal amplification methodology to detect the target antigen by a secondary antibody. Herewith, we will tackle both aspects and present innovative yet simple approaches to enhance the detection (electrochemical and optical) of the biological event. It is worth noting that the sandwich-type immunosensors to be developed can be easily adapted and tailored to a trial of interest. One crucial demand is the biocompatibility of the recognition layer and in this context supported lipid bilayers (SLB) may provide an ideal matrix for antibody immobilization. However, the formation of flat, uniform and air stable SLB on conductive surfaces remains a challenge and most works fail to use biologically relevant lipid mixtures. Recently, the team was able to prepare robust and raft forming SLB on gold surfaces [2-4], enabling direct electrochemical monitoring and control. The expertise of the team on the synthesis of metallic and semiconducting nanoparticles and their functionalization [5], enable to use suitable surface chemistry for the direct bio-functionalization of nanoparticles, with antibodies. The biorecognition reactions will be transduced electrochemically and optically in a partnership with a Chinese Group (Instutute of Mechanics, Beijing). In addition, a startup company, Lumisense Lda., will design and construct a microfluidic miniaturized immunosensor based on the developed platforms, directed to the detection of toxins in beverages.

Acknowledgements
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[1] J Rusling, The Chemical Record 12 (2012) 164–176.
[2] J. T. Marquês, R. F. M. de Almeida, A. S. Viana Soft Matter 8 (2012) 2007-2016.
[3] J. T. Marquês, A. S. Viana, R. M. F. de Almeida, Langmuir 30 (2014) 12627-12637.
[4] J. T. Marquês, I. Almeida, W. Liu, Y. Niu, R.F.M. de Almeida, G. Jin, A. S. Viana, Colloids and Surfaces B: Biointerfaces 136 (2015) 997-1003.
[5] I. Almeida, S.G. Mendo, M.D. Carvalho, J.P. Correia, A.S. Viana, Electrochimica Acta 188 (2016) 1–12.

CpHMD-L simulations of pHLIP peptides: design of new tumor-targeted drug delivery systems

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The pH (Low) Insertion Peptide (pHLIP) is a 36 amino acid peptide derived from bacteriorhodopsin [1] that targets tissues with acidic pH [2]. It simultaneously targets tumors, carries the cargo, and translocates it across the plasma membrane at low pH values [3]. At neutral pH, pHLIP is soluble as a monomer in water and associate with lipid bilayer surfaces largely as an unstructured peptide. Under acidic conditions, pHLIP inserts across a lipid bilayer with an apparent p*K* of 6, forming a transmembrane helix (Figure 1) [1]. The pH-dependent insertion process is coupled to the protonation of one or both of the Asp residues located in the transmembrane region of the peptide [1, 2].

Despite the extensive experimental studies on the mechanism and thermodynamics of pHLIP-membrane interactions [4], there is not enough information at the molecular level for a good understanding of the insertion phenomenon and its pre-requisites. These processes are usually only followed indirectly in typical biophysical experiments and cannot be modelled using conventional methodologies, like molecular dynamics or continuum electrostatics due to the inherent complexity associated with pH. Therefore, in this project, (PTDC/QEQCOM/5904/2014) we will employ computational methodologies (like our recently developed CpHMD-L method) to understand the molecular details of pH dependent peptide/membrane interaction and insertion.

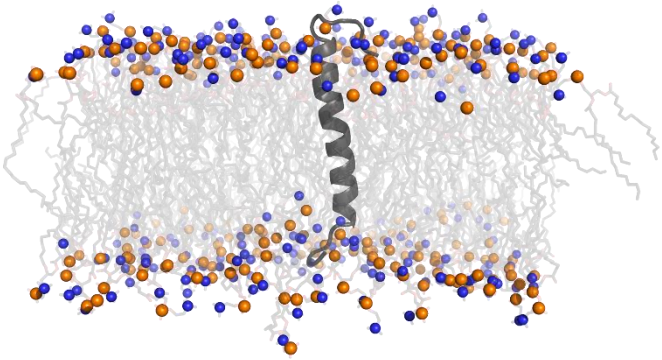

Figure 1. The pHLIP peptide inserted in a lipid bilayer.

Acknowledgements

We acknowledge financial support from FCT projects PTDC/QEQCOM/5904/2014 and UID/MULTI/00612/2013.

[1] J. F. Hunt, P. Rath, K. J. Rothschild, D. M. Engelman, Biochemistry, 36:15177 (1997)

[2] Y. K. Reshetnyak, O. A. Andreev, U. Lehnert, D. M. Engelman, PNAS, 103, 6460 (2006)

[3] Yao, L, Danniels, J, Moshnikova, A, Kuznetsov, S, Ahmed, A, Engelman, DM, Reshetnyak, YK, Andreev, OA (2012) PNAS, 110, 465

[4] D. Weerakkody, A. Moshinoka, M. S. Thakur, V. Moshinoka, J. Daniels, D. M. Engelman, O. A. Andreev, Y. R. Reshetnyak, PNAS, 9:5834 (2013).

Multifunctional luminescent spin labile hybrid materials

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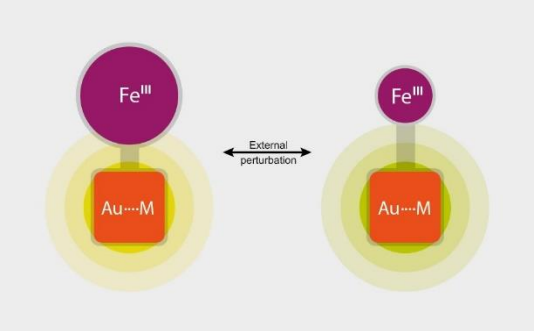
Data storage in binary systems operates by switching between two stable states under ambient conditions and information is written by application of a stimulus. Fabrication of typical data storage devices is made using a top-down approach where the size of magnetic domains has been constantly decreasing.[1] Reduction of size of magnetic domains is only possible until the super paramagnetic limit is reached, producing highly unstable devices.[2,3] To overcome the instability conferred by the superparamagnetic limit, scientists have been developing strategies using diverse and imaginative solutions. However, a new model of spin-based electronics, based on the orientation of individual electron spins to store binary information, offers the tantalizing possibility of non-volatility, increased data processing speed, decreased electric power consumption and increased integration densities.

Magnetic compounds with good potential for incorporation into spintronic materials include spin crossover transition metal compounds.[4] Research has been developed where bistable magnetic states in molecules are addressed mainly by application of temperature or light.

Engineering of multifunctional materials by combining both SCO and luminescence yields hybrid molecules and opens opportunities to develop a range of materials with applications in molecular electronics, nanomedicine and sensors technology.

This research proposal wishes to exploit the fact that is possible to combine more than one function in the same molecule forming hybrid molecular systems. This will be achieved by coordination of luminescent centres based on coinage metals to SCO molecules with functional acetylide groups. The research project here proposed consists of five major parts. The first part of the project is dedicated to the synthesis of both amphiphilic and unfunctionalised SCO Fe(III) molecules.



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[1] Dietzel, A., Hard Disk Drives in Nanoelectronics and Information Technology Wiley-VCH: Berlin, 2005.
[2] Charap, S. H., Pu-Ling, L., Yanjun, H., IEEE Trans. Magn., 1997, 33, 978-983.
[3] Martín, J. I., Nogués, J., Liu, K., Vicent, J. L., Schuller, I. K., J. Magn. Magn. Mater., 2003, 256, 449-501.
[4] Kahn, O., Martinez, C. J., Science, 1998, 279, 44-48.

Sphingolipid organization in the plasma membrane of *Saccharomyces cerevisiae*

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Sphingolipids [SLs] are major lipid components of the plasma membrane [PM] of eukaryotes and their organization in the PM is critical for many cellular vital functions [1]. There is evidence implicating SLs in the mechanism of action and resistance to antifungal agents in clinical use [2, 3]. Moreover, fungal resistance to antifungals is an emerging public health problem [4], many important antifungal agents act on the PM and SLs are potential therapeutic targets in fungal infections [3, 5]. Despite its recognized importance, SL organization in the PM of fungi remains poorly understood, even in *Saccharomyces cerevisiae*, and biophysical studies with yeast SLs are almost inexistent. Thus, the goal of this project is to define the structural features and molecular interactions of SLs which are crucial for the organization of the PM in *S. cerevisiae*, establishing the biophysical principles governing SLs role in the mode of action of antifungals and fungal resistance.

Acknowledgements
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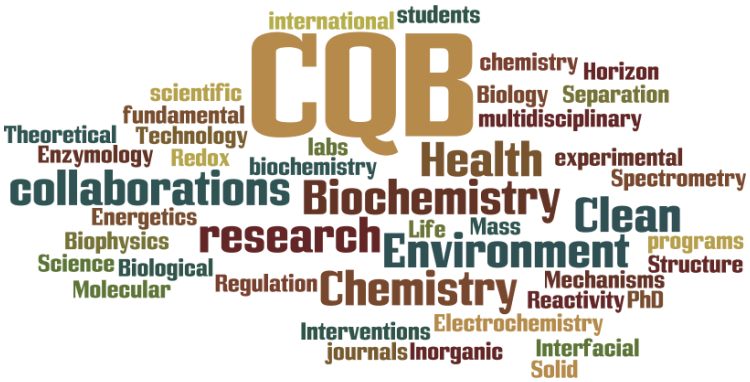
References
1. J. C. Holthuis, T. Pomorski, R. J. Raggers, H. Sprong, G. Van Meer, Physiol Rev. 81 (2001) 1689-1723.
2. I.E. François, A. Bink, J. Vandercappellen, K.R. Ayscough, A. Toulmay, R. Schneiter, E. van Gyseghem, G. Van den Mooter, M. Borgers, D. Vandenbosch, T. Coenye, B.P.A. Cammue, K. Thevissen, J. Biol. Chem. 284 (2009) 32680-32685.
3. K. Mukhopadhyay, T. Prasad, P. Saini, T.J. Pucadyil, A. Chattopadhyay, R. Prasad, Antimicrob. Agents Chemother. 48 (2004) 1778-1787.
4. A. Chakrabarti., Regional Health Forum 15 (2011) 97-103.
5. G.B. Wells, R.C. Dickson, R.L. Lester, J. Bacteriol. 178 (1996) 6223-6226.



Science at CQB

Poster Communications

Surfaces modified by bio-inspired molecules for molecular oxygen reduction catalysis

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The oxygen reduction reaction (ORR) is a sluggish reaction over any metal substrate, limiting the kinetics of the electrochemical devices using the molecular oxygen as oxidising agent [1]. The pursuit of new reliable substitutes of the conventional catalysts will lead to the preparation of materials with increased electrocatalytic activity and economically interesting in order to push forward the market of such electrochemical devices.

The purpose of this work is to develop a high performance cathodic catalyst for the ORR based on bio-inspired molecules (synthetic metalloporphyrins and Vitamin B12), that display a high intrinsic catalytic potential, as widely recognized by the scientific community [2-3]. To achieve this goal, porphyrin moieties were electrochemically immobilized on electrode surfaces. Cyclic voltammetry was employed to understand the electrochemical behaviour of the metal complexes in solutions over different substrates as well as that of the matrices assembled on the electrode surfaces. The catalyst was electrochemically deposited using two different approaches; a) by continuous potential cycling of the substrate in solutions containing the coordination compound and b) incorporation of the catalyst into a conducting polymer matrix during its synthesis using potentiodynamic and potentiostatic techniques. The electrochemical behaviour of the modified electrodes was characterized by cyclic voltammetry and their morphology by atomic force microscopy (AFM) and x-ray photoelectron spectroscopy (XPS). The dielectric constants and thickness of the thin films were assessed by multiangle *ex-situ* ellipsometry. The electrocatalytic performance of such materials towards the ORR was evaluated in neutral and acid media. To investigate the mechanism and kinetics of ORR at the different modified electrodes with the porphyrins it was used the rotating ring disk electrode technique.

Acknowledgements
This work is funded by FCT (Fundação para a Ciência e a Tecnologia) through the project UID/MULTI/00612/2013

[1] Perla B Balbuena and Venkat Subramanian, Theory and Experiment in Electrocatalysis, Springer, 2010
[2] R Fraga and JP Correia, Electrochimica Acta, 2005, 50, 1653-1659
[3] Karl M Kadish, Handbook of Porphyrin Science, Elsevier Science, 2003

Macrophage type lectin -galactose ligands: chemical synthesis

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Filoviruses, like Marburg and Ebola viruses, cause hemorrhagic diseases in humans and nonhuman primates with high rate of mortality. As other C-type lectins like DC-SIGN (Dendritic Cell-Specific Intercellular adhesion molecule-3-Grabbing Non-integrin), the macrophage galactose C-type lectin (MGL) binds to Ebola or Marburg virus glycoprotein (GP). The interaction is formed via the GalNAc residue directly linked to Ser/Thr side chains on the GP of the virus and promotes viral infectivity *in vitro*, by enhancing viral attachment to cellular entry receptors [1]. Furthermore, MGL is present on cells known to be major targets of filoviruses (i.e., macrophages and dendritic cells), suggesting a role for this receptor in viral replication *in vivo*. In this context, it was recently unravelled the interactions of GalNAc, Gal and tumor-associated MUC1 glycopeptides and MGL[2].

In this project we are synthetizing mimetics of GalNAc, for example, phenylselenyl galactosides bearing an imide functionality at position 2, that could better bind to MGL receptor than GalNAc itself, therefore competing to the interaction between MGL and the GP of Ebola or Marburg filovirus.

NMR spectroscopy has demonstrated its suitability to provide structural and dynamics information, at an atomic level, of carbohydrate-protein complexes [3]. The interaction of GalNAc mimetics and MGL lectin receptor will be monitored by NMR binding studies in combination with molecular modelling simulations, to clarify the key interacting features of the new molecules. NMR data of the new glycomimetics, including affinity data, will also be compared to those of the natural GalNAc ligand.

Acknowledgements
The authors thank Fundação para a Ciência e a Tecnologia for the support of the project UID/MULTI/00612/2013.

References
[1] Takada, A., Fujioka, K., Tsuiji, M., Morikawa, A., Higashi, N., Ebihara, H., Kobasa, D., Feldmann, H., Irimura, T., Kawaoka, Y., (2004) Human Macrophage C-Type Lectin Specific for Galactose and N-Acetylgalactosamine Promotes Filovirus Entry, J. Virology, 78, 2943-2947;
[2] Marcelo F., Garcia-Martin F., Matsushita T., Sardinha J., Coelho H., Oude-Vrielink A., Koller C., André S., Cabrita E. J., Gabius H.-J., Nishimura S.-I., Jiménez-Barbero J., Cañada F. J., (2014) Delineating binding modes of Gal/GalNAc and structural elements of the molecular recognition of tumor-associated mucin glycopeptides by the human macrophage galactose-type lectin, Chem. Eur. J. 20, 16147-16155. VIP Paper.
[3] Fernández-Alonso M. C., Díaz D., Berbis M. A., Marcelo F., Jiménez-Barbero J., (2012) Protein-carbohydrate interactions. From molecular recognition to drug design. Curr. Protein Pept. Sci., 13, 816-8

Extraction and analysis of sphingolipids from *Saccharomyces cerevisiae* wild type cells and in a sphingolipid biosynthetic mutant

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The yeast *Saccharomyces cerevisiae* exhibits a composition in ergosterol and sphingolipids in the plasma membrane similar to pathogenic fungi, being ergosterol the main target of chemical agents against these fungi[1].

On another hand, *S. cerevisiae* cells, such as *ipt1Δ* deletion mutant, which are unable to synthesize the sphingolipid mannosyl-diinositolphosphorylceramide, $M(IP)_2C$, show greater resistance to antifungal agents, such as miconazole[2] and nystatin[3]. This strain has ergosterol content similar to the wild type strain. Therefore, the mechanisms of this resistance may involve sphingolipid domains, which in yeast may be ergosterol depleted[4].

For the reasons above, it is important to study the sphingolipid influence in the plasma membrane organization of *S. cerevisiae*. To this end, we intend to isolate and perform a thorough biophysical characterization of each complex sphingolipid class present in the plasma membrane of that organism separately. Before that, it is however, necessary that the sphingolipid extraction from yeast cells is optimized.

After obtaining the total lipid extracts, the lipids have to undergo mild alkaline hydrolysis to hydrolyze the glycerophospholipids, but not the sphingolipids. The sphingolipid extracts thus obtained are then analyzed by thin layer chromatography. If good separation is reached, a purified sample of each sphingolipid can be extracted from the respective band.

Several optimization steps using model lipid mixtures were needed to reach the most suitable time of hydrolysis, since longer times can hydrolyze not only glycerophospholipids but also sphingolipids and shorter times may hydrolyze incompletely the glycerophospholipids.

Regarding the yeast lipid extracts, obtained using the Fölch method, it was only possible to identify unequivocally the sphingolipid mannosyl-inositolphosphorylceramide (MIPC), in both wt and ipt1Δ extracts. The impossibility to observe $M(IP)_2C$ may be due to low extraction efficiency of this highly polar lipid and consequently new methods are required to overcome this obstacle, which are now being attempted.

It was possible to observe no differences when it comes to the contents in glycerophospholipids and ergosterol between the two strains. However, an increase in the amount of MIPC in *ipt1Δ* extracts was perceptible, as expected.

Acknowledgments

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1. Castelli, M. V. *et al.* Novel antifungal agents: a patent review (2011 - present). *Expert Opin. Ther. Pat.* **24,** 323–338 (2014).
2. François, I. E. J. A. *et al.* Membrane rafts are involved in intracellular miconazole accumulation in yeast cells. *J. Biol. Chem.* **284,** 32680–32685 (2009).
3. Leber, A., Fischer, P., Schneiter, R., Kohlwein, S. D. & Daum, G. The yeast mic2 mutant is defective in the formation of mannosyl-diinositolphosphorylceramide. *FEBS Lett.* **411,** 211–214 (1997).
4. Aresta-Branco, F. *et al.* Gel domains in the plasma membrane of Saccharomyces cerevisiae: highly ordered, ergosterol-free, and sphingolipid-enriched lipid rafts. *J. Biol. Chem.* **286,** 5043–5054 (2011).

Polydopamine films modified with Laccase for electrochemical biosensing

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Laccases (Lac) are versatile oxidoreductases known by their wide applicability in wastewater treatments, textile and paper industries, delignification processes, biofuel cells and biosensors[1]. Despite their excellent catalytic properties towards several substrates, more reliable immobilization strategies are needed to stabilize the enzyme in a solid surface and to allow their reusability[2]. Common electrode modification approaches, such as self-assembled monolayers, are not applicable to all surfaces and may involve multi-step procedures[3]. In contrast, the bio-inspired polydopamine (PDA) films can spontaneously grow on a variety of surfaces, creating a biocompatible interface with interesting adhesive properties[4]. This highly functional films enriched with quinone groups are able to covalently bind target biomolecules, such as Laccases, through a Schiff base reaction or Michael type additions[5]. In this work we have modified glassy carbon and graphite electrodes with spontaneously formed or electrochemically synthesized polydopamine films for the covalent immobilization of two types of commercial Laccases: purified powder and cocktail booster form(Figure 1). Several PDA films with different thicknesses were grown on glassy carbon and their electrochemical properties were evaluated by cyclic voltammetry. Ellipsometric measurements allow to correlate the film thicknesses with time deposition or polymerization potential cycles. Contact angle goniometry disclose the hydrophilic nature of PDA, whereas morphological information was provided by AFM onto highly oriented pyrolytic graphite. This multitude of techniques revealed the properties of both polydopamine types and allow to maximize the catalytic performances of carbon/PDA/Lac biosensors, that were evaluated afterwards by cyclic voltammetry and chronoamperometry towards different substrates.

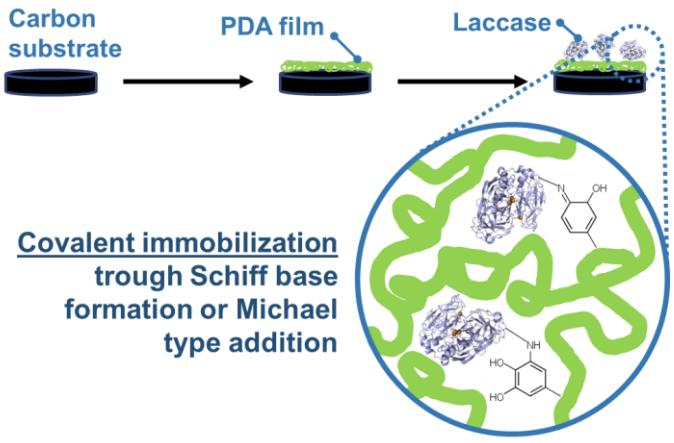

Figure 1. Two-step methodology used for the carbon/PDA/enzyme preparation.

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[1] S.R. Couto, J.L.T. Herrena, Biotechnology Advances, 24 (2006) 500-513.
[2] C. Mateo, J.M. Palomo, G. Fernandez-Lorente, J.M. Guisan, R. Fernadez-Lafuente, Enzyme and Microbial Technology 40 (2007) 1451–1463.
[3] I. Almeida, V.C. Ferreira, M.F. Montemor, L.M. Abrantes, A.S. Viana, Electrochimica Acta, 30 (2012) 311-320.
[4] Y. Lui, K. Ai, L. Lu, Chemical Reviews, 114 (2014) 5077-5115.
[5] E. Faurea, C. Falentin-Daudréa, C. Jérômea, J. Lyskawa, D. Fournier, P. Woisel, C. Detrembleur, Progress in Polymer Science, 38 (2013) 236-270.

Synthesis of new antibiotic glycosides and computational studies on their interaction with model lipid bilayers

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The spread of bacterial resistance to the available therapeutics is considered a major public health threat to contemporary societies. In the search for innovative sugar-based antibiotics with new mechanisms of action, our research group has successfully generated a family of surfactant glycosides exhibiting potent antibacterial activity against several pathogens including *Bacillus anthracis*, which is considered a bioterrorism agent [1]. In particular, a series of alkyl 2-deoxy- and 2,6-dideoxy-*arabino*-hexopyranosides were accessed by reaction of fatty alcohols with protected glycals in the presence of triphenylphosphane hydrobromide, an efficient procedure that stereoselectively delivers the bioactive α-glycosides in high yields. Their antibacterial activity is modulated by the deoxygenation pattern of the sugar moiety, and preliminary mechanistic studies indicate that these molecules act through the destabilization of bacterial cell membranes.

With the intent to further rationalize the structural key features for glycoside bioactivity, we designed and synthesized a small library of analogues related to the most active compound, including 2-deoxyglycosides derived from pentoses, 2-fluorinated analogues and glycosides deoxygenated at 6-position of the sugar, which were screened for their potential antibacterial activity. In addition, we applied molecular dynamics simulations to study the interactions of these molecules, as well as the aggregates they form in solution, with model phospholipid membranes. Particularly, we modelled the partitioning of glycosides into the lipid bilayer at the interface and analyzed the effect of these events on membrane thermotropic properties. This computational study provided important insights into their mechanism of action which will also be disclosed.

Acknowledgements

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[1] A. Martins, M. S. Santos, C. Dias, P. Serra, V. Cachatra, J. Pais, J. Caio, V. H. Teixeira, M. Machuqueiro, M. S. Silva, A. Pelerito, J. Justino, M. Goulart, F. V. Silva, A. P. Rauter, Eur. J. Org. Chem. 8 (2013) 1448-1459.

Comparative study between Grunwald-Winstein and TAKA parameters used for the study of solvent effects

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Grunwald-Winstein plots [1] and TAKA model equation [2] have been used over time to rationalize solvent effects in solvolysis reactions. To our knowledge, very little has been done to correlate both sets of parameters to understand if they deliver the same type of mechanistic information.

One reason for this might be the fact that there are very few, disperse and inconsistent data in the literature regarding solvatochromic parameters for the typical Grunwald-Winstein (G-W) mixtures which involve mainly the following solvent systems: ethanol/water, methanol/water, acetone/water, trifluorethanol/water and trifluorethanol/ethanol.

In this work, Kamlet-Taft parameters (π^*, α and β) have been determined at 298.15 K on the basis of the spectroscopic shifts of five solvatochromic probes (betaine (30), 4-nitrophenol, 4-nitroanisole, 4-nitroaniline and *N*,*N*-dimethyl-4-nitroaniline), for the referred G-W solvent mixtures, in order to establish a coherent matrix of solvatochromic parameters.

Correlations between G-W N and Y scales and TAKA π^*, α and β scales have been established showing that the former can be in fact expressed as linear combinations of the TAKA parameters, thus confirming the unsuspected similarities between both approaches.

Acknowledgements
The authors are grateful to Fundação para a Ciência e a Tecnologia, Portugal, for financial support under project UID/MULTI/00612/2013.

[1] E. Grunwald, S.Winstein, J. Amer. Chem. Soc. 73 (1951) 2700-2707.
[2] R. W. Taft, J. L. M. Abboud, M. J. Kamlet, M. H. Abraham, J. Sol. Chem. 14 (1985) 153-186.

Synthesis and hepatotoxicity of psychoactive cathinones

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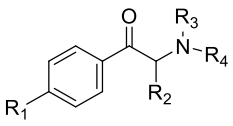
In the last few years, there has been an uprising of new psychoactive substances (NPS) available in "smartshops" and over the Internet. NPS are "new narcotic or psychotropic drugs that are not listed in the Single Convention on Narcotic Drugs of 1961 or the Convention on Psychotropic Substances of 1971, but which may constitute a public health threat comparable to the one posed by substances listed in those conventions". Since 2005 more than 560 novel NPS have been reported to the Early Warning System (EWS) in Europe, of which 103 are synthetic cathinones being 22 firstly reported in 2015 and 31 in 2014, rendering this class of compounds one of the widest category of NPS known to date [1]. Cathinones are β-keto phenethylamines derivatives, structural analogues of the natural-occurring cathinone, the psychoactive stimulant found in the khat plant.

The neuropharmacological action of cathinones is similar to those of more traditional illicit psychostimulants, such as D-amphetamine, methamphetamine and MDMA, and is related with the increase of synaptic concentration of the monoamines dopamine, norepinephrine and serotonin, either by inhibiting the corresponding transporters (SERT, NET and DAT) or by increasing the pre-synaptic release of the neurotransmitters. In addition it is now known that different synthetic cathinones have diverse mechanisms of action, which strongly depends on their structure [2].

An increasing number of cases of severe liver injury have been reported, as a consequence of khat use or abuse, particularly in countries where *Catha edulis* is legal[3]. Recently a study on the in vitro hepatotoxic effects of some individual synthetic cathinones, namely methylone, pentedrone, 4-methylethcathinone (4-MEC) and 3,4-methylenedioxypyrovalerone (MDPV) revealed that MDPV was the more toxic compound[4].

The aim of this work was to evaluate, in a comprehensive way, the hepatotoxicity of a series of synthetic cathinones: methcathinone, buphedrone, pentedrone, mephedrone (4-MMC), 4-MEC, α-PPP α-PBP and α-PVP (Fig. 1), enabling the identification of structural determinants of hepatotoxicity.

Eight cathinones were synthesized and evaluated against human hepatoma cell line Hep G2. Results on *in vitro* hepatotoxicity seem to disclose that cathinones hepatotoxicy varies significantly with their structure. The amine connected to the carbonyl α-carbon seems to be irrelevant to the toxicity, which is dependent of the length of the ketone chain and on methyl substitution of the aromatic ring. The more toxic cathinone was mephedrone with an EC 50= 1.38mM (used as control), followed by 4-MEC with an EC 50= 1.50 mM.



Methcatinone	R_1=R_3= H; R_2=R_4= CH_3
Bufedrona	R_1=R_3= H; R_2= CH_2CH_3; R_4= CH_3
Pentedrona	R_1=R_3= H; R_2= $CH_2CH_2CH_3$; R_4= CH_3
α-PPP	R_1= H; R_2= CH_3; R_3,R_4= Pyrrolidine
α-PBP	R_1= H; R_2= CH_2CH_3; R_3,R_4= Pyrrolidine
α-PVP	R_1= H; R_2= $CH_2CH_2CH_3$; R_3,R_4= Pyrrolidine
4-MMC	R_1= R_2= R_4= CH_3; R_3= H
4-MEC	R_1= R_2= CH_3; R_3= H; R_4= CH_2CH_3

Figure 1. General structure of the tested cathinones

Acknowledgments

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[1] European Monitoring Centre for Drugs and Drug Addiction and Europol (2016), EU Drug Markets Report: In-Depth Analysis, EMCDDA–Europol Joint publications, Publications Office of the European Union, Luxembourg.

[2] L.D. Simmler, T.A. Buser, M. Donzelli, Y. Schramm, L.H. Dieu, J. Huwyler, S. Chaboz, M.C. Hoener, M.E. Liechti, Brit J Pharmacol, 168 (2013) 458-470.

[3] F. Pantano, R. Tittarelli, G. Mannocchi, et. Al. Int. J. Mol. Sci. (2016) 17 580

[4] A.M. Araújo, M.J. Valente, M. Carvalho, D.D. Silva, H. Gaspar, F. Carvalho, M.L. Bastos, P.G. Pinho, Arch Toxicol (2015) 89 757–771.

Thermodynamic study of aqueous mixtures of 3-butoxypropan-1-amine

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Alkoxyamines are versatile compounds with great affinity for water since they have in their structure the alkoxy and amine functional groups. They have been used in industry for the immobilization of various compounds such as biomolecules by means of condensation reactions with aldehydes or ketones forming oxime bonds, which increase their stability [1]. Additionally, the strong electron-donor functional groups of alkoxyamines have been largely used in polymer chemistry to produce sequence-controlled polymerization and cyclization reactions [2]. Pursuing the volumetric studies [3-5] dedicated to improve comprehension embracing molecular interactions in binary systems water + amphiphilic molecules, the density, ρ, and sound speed, u, in water (1) + 3-butoxypropan-1-amine (BPA)(2), spanning the temperature range (283.15 to 303.15) K and over the entire composition range were determined. A comparison of the present results with those obtained for the system water + 3-ethoxypropan-1-amine (EPA) is made addressing the changes produced by the hydrophobic characteristics of the molecules. These studies are undertaken in order to clarify the influence of structure, chain length and type of hydrophilic groups on the aggregation and hydration schemes.

Derived thermodynamic quantities revealing changes of molecular aggregation with temperature and composition across the whole composition range. The profile of the curves of partial molar properties, which entails first order derivatives of the molar volumes and molar isentropic compressions, shows at least three different regimens of molecular aggregation (Figure 1).

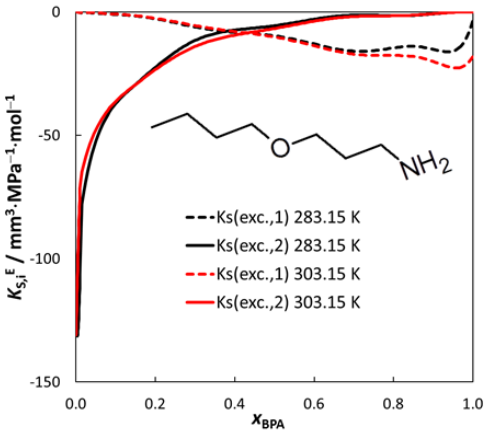

Figure 1 Excess partial molar isentropic compressions

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[1] M.R. Hill, S. Mukherjee, P.J. Costanzo, B.S. Sumerlin, Polym. Chem. 3 (2012) 1758–1762.
[2] C. St. Thomas, H. Maldonado-Textle, A. Rockenbauer, L. Korecz, N. Nagy, R. Guerrero-Santos, J. Polym. Sci. Part A: Polym. Chem. 50 (2012) 2944–2956.
[3] E. Bulemela, P.R. Tremaine, J. Phys. Chem. B, 112 (2008) 5626–5645.
[4] M.-L.C.J. Moita, L.M.V. Pinheiro, Â.F.S. Santos, I.M.S. Lampreia, J. Chem. Eng. Data 57 (2012) 2290-2295.
[5] L.M.V. Pinheiro, M.-L.C.J. Moita, Â.F.S. Santos, I.M.S. Lampreia, J. Chem. Thermodyn. 64 (2013) 93-99.

The spin crossover profile in iron(III) Schiff-base compounds: halogen influence

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Technological advances have been pushing the limits of chemistry for the last few years towards creating more efficient and multifunctional molecules and materials. A phenomenon that shows great promise in molecular electronics is spin crossover (SCO).[1] This switching can be harnessed to develop materials with a wide range of possible applications such as memory or sensing nano-devices.[2] Halogen derivatized SCO molecules are of great interest as they can interact with neighboring molecules through either halogen or hydrogen bonds and additionally they can be modified through substitution or coupling reactions conferring additional properties and high versatility to the SCO molecules.[3,4]

Here we report the synthesis and characterization of halogen derivatized SCO compounds with an Fe(III) metallic center coordinated to tridentate (N2O) Schiff-base ligands. We have found that all compounds exhibit SCO with profiles ranging from gradual to abrupt with hysteresis and a detailed study on the halogen influence on these is also being carried out.

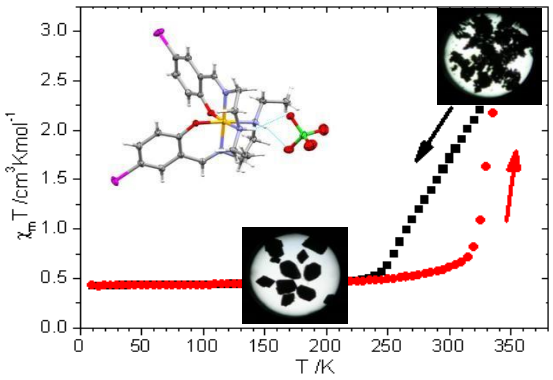

Figure 1 – Sample magnetic profile, x-ray crystal structure and picture of synthesized compounds

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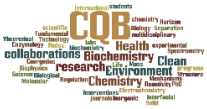
[1] Gamez, P.; Costa, J. S.; Quesada, M.; Aromí, G., Dalton Trans. 2009, 38, 7845.
[2] Létard, J.; J. Mater. Chem. 2006, 16, 2550.
[3] Devid, E. J.; Martinho, P. N.; Kamalakar, M. V.; Šalitroš, I.; Prendergast, Ú.; Dayen, J. F;Meded, V.; Lemma, T.; González-Prieto, R.; Evers, F.; Keyes, T. E.; Ruben, M.; Doudin, B.; van der Molen, S. J., ACS nano 2015, 9, 4496.
[4] Gaspar, A. B.; Ksenofontov, V.; Seredyuk, M.; Gütlich, P., Coord. Chem. Rev. 2005, 249, 2661.



The ability of sterols to form liquid ordered domains links membrane biophysical properties to biological processes

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The major sterol present in the plasma membrane of fungi and mammalian cells – ergosterol (erg) and cholesterol (chol), respectively – present small structural differences, given that they share a common metabolic precursor, zymosterol (zym), close to the final step of their biosynthetic route. In this work, we have studied the importance of these structural differences for the formation and properties of sterol-enriched plasma membrane microdomains (lipid rafts) in eukaryotes. To better understand sterol evolution *in vivo*, liposomes containing chol, erg or zym were prepared and different biophysical properties were assessed *in vitro*.

Emission spectra of di-4-ANEPPS, a dye sensitive to sterol-phospholipid interactions, show that chol and erg interact differently with saturated (DPPC, gel phase) and unsaturated (POPC, liquid disordered l_d phase) glycerophospholipids, whereas zym interacts similarly with both. The stronger interaction of erg and chol with saturated phospholipids led to the formation of liquid ordered (l_o) raft-like domains, while zym showed no capacity to form them. These results were consistent with confocal fluorescence imaging of microdomains in giant unilamellar vesicles

The study of sterol effect on lipid bilayer passive permeability to water and to univalent cations (H^+/K^+ exchange), using binary and ternary mixtures, also corroborated the behavior described above. The presence of erg or chol in DPPC bilayers markedly increased the passive permeability of the membrane to water, concomitant with a change from gel to l_o phase. Zym, however, had only a marginal effect. Furthermore, in lipid mixtures containing both saturated and unsaturated phospholipids, zym failed to induce the decrease of passive permeability observed for the raft-forming sterols. These results corroborate that the addition of zym does not change the gel/l_d coexistence, a situation where the domain interface packing defects are responsible for most of the observed permeation, whereas the presence of erg and chol shifts this regime to a coexistence of l_o-l_d domains, with much less interfacial defects.

Additionally, we determined the total expression and distribution in the plasma membrane of Can1p-GFP, a marker of erg-enriched microdomains, in wild-type (wt) and *erg6*Δ yeast cells. The results revealed a similar heterogeneity degree at the plasma membrane but a higher level of expression, possibly to compensate for traffic defects at the level of the Golgi complex also registered in *erg6*Δ cells.

Taken together, our *in vitro* evidence for the inability of zym to promote the formation of l_o-like domains provide a biophysical foundation for the observed increased permeability to small water-soluble dyes and stress sensitivity as well as defective lipid-raft dependent traffic observed in zym-enriched *erg6*Δ *S. cerevisiae* cells, when compared to wt cells. Hence, this work supports the hypothesis that lipid raft formation in fungi and mammalian cellular membranes is a convergent evolutionary trait that assures the establishment of the biophysical properties necessary for biological membrane responses.

Acknowledgements

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[$VCl_3\{\eta^3$-$HC(pz)_3\}$]@CNT as catalysts for the microwave-assisted oxidation of xylenes

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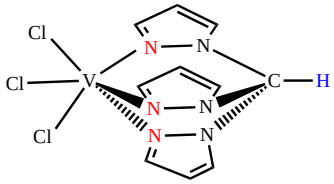
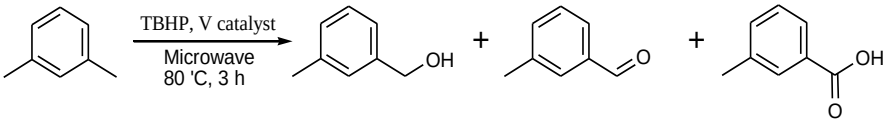
Oxidation is a widely used synthetic route for a large range of chemicals. Important oxidation substrates are alkyl aromatics, such as xylenes [1]. However, the oxidation of xylenes with peroxides, as well as under heterogeneous conditions, is scarce. This prompted us to consider the application of a catalyst able to oxidize alkanes in homogeneous conditions [2] to the heterogeneous oxidation of different xylenes. This was carried out through heterogenisation of a homogeneous complex on a heterogeneous carbon support.



Scheme 1 – Vanadium complex [1].

The C-scorpionate trichloro-vanadium (III) complex [$VCl_3\{\eta^3$-$HC(pz)_3\}$] (pz = pyrazolyl) [1], shown in Scheme 1, was supported on multiwalled carbon nanotubes (CNT) and characterized by SEM, TEM, BET and XPS. The heterogeneized complex was used as catalyst for the MW-assisted solvent free oxidation of xylenes with *tert*-butyl hydroperoxide (TBHP), under mild conditions (see Scheme 2 for *m*-xylene, where the main products are *m*-methylbenzylalcohol, *m*-methylbenzaldehyde and *m*-methylbenzoic acid). The effects of different reaction parameters are discussed.



Scheme 2 – Oxidation of xylene under solvent free conditions.

Acknowledgements

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[1] R. A. F. Tomás, J. C. M. Bordado, J. F. P. Gomes, Chem. Rev. 113 (2013) 7421−7469.
[2] T. F. S. Silva, E. C. B. A. Alegria, L. M. D. R. S. Martins, A. J. L. Pombeiro, Adv. Synth. Catal. 350 (2008) 706–716.

Force fields for lipid bilayers: How do they work?

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The lipid bilayer is the basic structure of biological membranes, which define the boundaries of all cells and regulate the movement of molecules between cells and their environment. Membranes also enable other functions such as inter-cellular communication and energy conservation; in eukaryotic cells, membranes form discrete compartments constituting organelles, the specialized subcellular structures optimized for specific metabolic processes. However, lipids have been found to have more than a simple structural role [1,2].

In recent years, the field of molecular modeling of lipids has evolved significantly due to increases in computational power and improved force fields. Nevertheless, there are still serious limitations in all available force fields used to simulate lipid bilayers, which hinders further developments.

In this work, we studied how the most common lipid force fields are able to retain phosphocholine membranes in their fluid phases (Figure 1). Because lipids tend to gelidify, force fields developed tricks to keep them apart. In the case of GROMOS, we identified that the partial charges in the ester groups are determinant. We are currently investigating if a similar mechanism occurs in AMBER Lipid14 and CHARMM36 force fields.

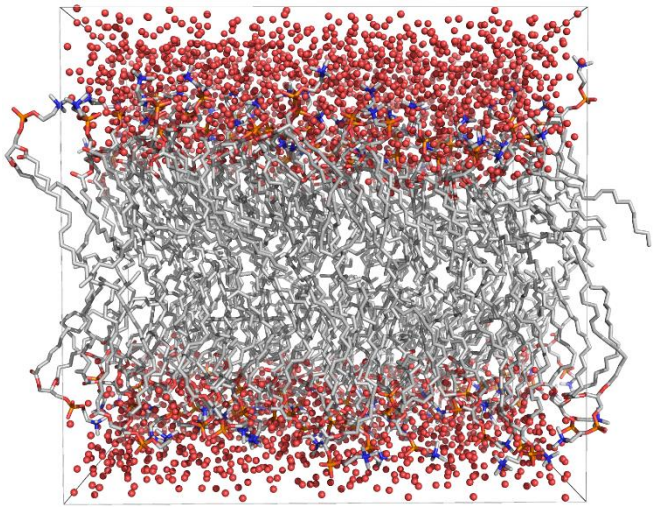

Figure 1. POPC lipid bilayer in the fluid phase.

Acknowledgements
We acknowledge financial support from FCT projects UID/MULTI/00612/2013 and PTDC/QEQCOM/5904/2014.

[1] Loewen, C.; Gaspar, M.; Jesch, S.; Delon, C.; Ktistakis, N.; Henry, S.; Levine, T. Science, 304 (2004), 1644−1647.
[2] Young, B. P.; Shin, J. J. H.; Orij, R.; Chao, J. T.; Li, S. C.; Guan, X. L.; Khong, A.; Jan, E.; Wenk, M. R.; Prinz, W. A.; Smits, G. J.; Loewen, C. J. R. Science, 329 (2010), 1085−1088.

One-step chemical immobilization of Laccase and Fe_3O_4 nanoparticles on gold for biosensing applications

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Immobilization of enzymes on an appropriate support is a crucial step for the construction of biosensors and many efforts have been made in this field, especially combining enzymes with conductive materials [1]. The attachment of biomolecules on semiconducting metal oxide surfaces, such as magnetic iron oxide nanoparticles (Fe_3O_4 NPs), has been increasingly investigated, since these nanomaterials ensure the preservation of enzyme biological activity, with an amplification of the electrochemical signal [2].

In this work, a simple one-step methodology was explored for the preparation of enzyme-modified electrodes to be employed in biosensing interfaces (Figure 1). Small amine-containing molecules (epinephrine and hexylmethylamine) were used as proof-of-concept of the proposed methodology, whereas the enzyme Laccase is employed aiming the preparation of a sensitive biosensor towards phenolic compounds. This approach relies on the in situ dithiocarbamate formation between carbon disulfide and the amine groups of biomolecules [3,4], and also on the strong affinity between sulfur moieties and metals. The reactivity between carbon disulfide, Fe_3O_4 NPs with two distinct average sizes (ca. 20 and 40 nm)) and amine groups, was firstly investigated using the hormone epinephrine, a small electroactive compound. A high amount of immobilized epinephrine and a facilitated redox conversion was obtained for modified electrodes with the larger NPs. Chronoamperometric studies of Laccase functionalized gold electrodes revealed a significant improvement of catalytic activity toward 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid (ABTS), when Fe_3O_4 NPs were added into the reaction. This effect was particularly noticed in the presence of the larger magnetite nanoparticles, which showed a very good sensitivity for ABTS oxidation (100 mA M^{-1} cm^{-2}). UV-visible spectroscopy confirmed the functionalization of nanoparticles by dithiocarbamate groups and atomic force microscopy was used to characterize the morphology of the nanostructured electrodes.

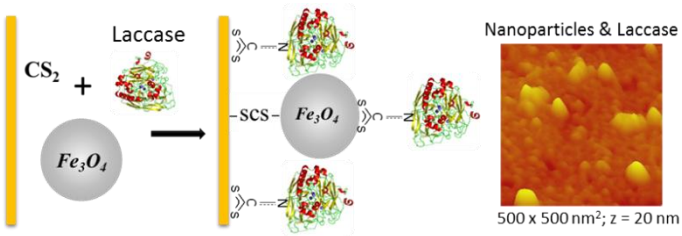

Figure 1 - Schematic representation of the one-step method exploited in this work and an AFM image of modified electrode with Laccase and Fe_3O_4 NPs.

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[1] M. M. Rodríguez-Delgado, G. S. Alemán-Nava, J. M. Rodríguez-Delgado, G. Dieck-Assad, S. O. Martínez-Chapa, D. Barceló, R. Parra, Trends in Analytical Chemistry 74 (2015) 21–45.
[2] X. Shi, W. Gu, B. Li, N. Chen, K. Zhao, Y. Xian, Microchim. Acta 181 (2014) 1-22.
[3] I. Almeida, A. C. Cascalheira, A. S. Viana, Electrochim. Acta 55 (2010) 8686-8695.
[4] I. Almeida, V. C. Ferreira, M.F. Montemor, L.M. Abrantes, A. S. Viana, Electochim. Acta 83 (2012) 311-320.

Bioactive compounds from agriculture and food industry residues

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Residues from agriculture or food industry constitute a big environmental problem. Some of these residues like leaves from fruit tree pruning and peels from juice industry can be used for obtaining compounds with biological activities[1] and give some added-values to these residues. In the present work leaves from *Actinedea deliciosa* (kiwi-fruit tree) (Fig.1a) and peels from avocado (Fig. 1b) were extracted with water to obtain phenolic compounds with several biological activities. The aqueous extracts contained a mixture of phenolic compounds, identified by LC-MS/MS among which proanthocyanidin B, proanthocyanidin C, rutin, quercetin 3-*O*-rutinoside-7-*O*-glucoside, quercetin 3-*O*-rhamnoside 7-*O*-glucoside, myricetin rhamnoside, quercitrin, naringin 6'-malonate, can be idientified in *A.deliciosa* and the avocado peels contains epicatechin, 7-β-D-glucopyranosyl-11-methyloleoside, 1,3,4-tri-*O*-galloylquinic acid, apigenin-acetyl-apiosylglucoside, quercetin dihexoside, proanthocyanidin B, proanthocyanidin C and quercetin-*O*-hexoside-*O*-pentoside. The mixture of phenolic from *A.deliciosa* and avocado peels had the capacity to scavenge free radical DPPH with an EC_{50} of 12.8 μg/mL, and 48.9 μg/mL, respectively, Table 1. The Acetylcholinesterase inhibitory activity as well as the capacity to inhibit lipid peroxidation is shown in Table 1. The cytotoxicity of extracts assessed using Caco-2 and MTT viability showed that *A. deliciosa* extract were not toxic towards this cell line, with a 2.8% toxicity for concentration of 0.1 mg/mL (IC_{50}<0.1 mg/ mL is considered toxic[2]). The toxicity of avocado peel extract towards HepG2 cells showed and IC_{50} value of 0.5 mg/mL. Permeability studies were also carried out using the extract from the leaves of *A.deliciosa* and the rutin and quercitrin in the extract permeated the intestinal barrier simulated by caco-2 cells in 9%.

Figure 1: Source of phenolic compounds (a): *Actinedea deliciosa* leaves and fruit; (b) avocado peels.

Table 1: Acetylcholinesterase inhibitory activity IC_{50} (mg/mL), antioxidant activity EC_{50} (DPPH, μg/mL) and lipid peroxidation inhibitory activity IC_{50} (TBARs μg/mL).

	DPPH (μg/mL)	AChE (mg/mL)	TBARS (μg/mL)
Actinedea deliciosa	13.0 ± 2.0	0.79 ± 0.01	331 ± 19
Persea Americana	49.0 ± 0.6	3.04 ± 0.03	780 ± 50

In conclusion: phenolic compounds from *A. deliciosa* leaves and avocado peels with antioxidant activity can be obtained using a cheap and green method.

Acknowledgements

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[1] S. Kumar, A.K.Pandey, The Scientific World Journal 2013 (2013), Article ID 162750.

[2] M. Cardenas, M. Marder, V.C. Blank, L.P. Roguin, Bioorg. Med. Chem. 14 (2006) 2966–2971.

Anticancer and antioxidant activity from cork waste water

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This study aims to purify high value compounds from cork effluent fractions obtained using ultrafiltration membranes of cellulose acetate in order to accomplish the identification of the compounds recovered in the fractions and the evaluation of its potential as anticancer and antioxidant.
Cork is bark from the cork oak, is a plant tissue that covers the trunk of the tree and which can be removed every 9 years. In order to be used in industry, the planks have to be cooked in water, after which various cooking cycles must be replaced, leading to the so-called cork wastewater. [1] This wastewater has a high organic loading rate and a high concentration of tannins and other polyphenols, and as such should be treated before proceeding to discharge. One of the strategies for the treatment of such effluent is the use of membranes, including most importantly the processes of reverse osmosis, microfiltration and ultrafiltration.[2]

Figure 1 – Cooking stage of cork boards

The pharmacological potential of cork lies in its low molecular weight components, such as the tannins, sterols, flavonoids and simple phenolic compounds. These show potential as anticancer, antimutagenic, antiallergic and anti-aging, and furthermore antioxidants derived from natural products can be less expensive than the synthetic variants.[1]

The effluent was fractionated using two ultrafiltration membranes prepared in the laboratory by reverse-phase method. Fractions were assayed in terms of phenols[3], tannins[4] and sugars[5]. Studies were undertaken such as antioxidant activity[6], cytotoxicity studies and inhibition of cell proliferation in cell lines MCF-7. Additionally the compounds present in each fractions were also identified by LC-MS.
Some of the fractions collected demonstrated antioxidant activity values and inhibition of cell proliferation promising results. Regarding the cytotoxicity it can be said that none of the fractions has cytotoxic activity. Therefore, fractionation of the cork effluent by membrane process is an alternative to conventional treatment of such effluent, and permits recovery of the fractions, as well as the recovery of important bioactive compounds.

Acknowledgements
FCT for the programmatic financing reference number: UID/MULTI/00612/2013.

[1] Silva S. P., Sabino M. A., Fernandes E. M., et al.., Int. Mat. Rev., 50 (2005) 345–365.
[2] Bernardo M., Santos A., Cantinho P., Minhalma M., Water Res.45 (2011) 904–912.
[3] M. Oktay, I. Gülçin, Ö.İrfan Küfrevioğlu, Food Sci.Technol. 36 (2003) 263-271.
[4] J. P Van Buren, W. B. Robinson, J. Agric. Food Chem.17 (1981) 772–777.
[5] X. Yong-Quan, H. Xiong-Fei, T. Ping, J. Yong-Wen, et al., Food Chem. 172 (2015) 831-835.
[6] P.L. Falé, C. Ferreira, M.H. Florêncio, M. L. Serralheiro, et al. J. Med. Plants Res.7 (2013)1370-1378.

Synthesis of novel nucleos(t)ide and glycosyl phosphate analogs or mimetics possessing therapeutic potential

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Nucleoside and nucleotide analogs have attracted considerable attention as synthetic targets due to their propensity to display antiviral and antitumor effects.[1] This bioactivity profile arises from their ability to interfere in biological processes in which natural nucleos(t)ides play key roles, such as nucleic acid synthesis and cell division, which are deregulated in diseases such as cancer or viral infections. Other biological properties have been reported for these classes of compounds, such as antimicrobial efficacies[2] and cholinesterase inhibitory abilities.[3] The access to structurally new analogs or mimetics of nucleosides and of nucleotides and the exploitation of their biological potential remains of interest.

In this communication, the synthesis of glucopyranos-6′-yl purines and pyrimidines as new types of regioisomers of nucleosides and that of glucuronamide-derived *N*-glycosyl compounds, including nucleosides and derivatives containing potential bioisostere groups for a phosphate functionality, will be presented.

6′-Isonucleosides were synthesized *via* Mitsunobu coupling between partially protected methyl glucopyranosides and various nucleobase derivatives.[4,5] The outcome of the reaction was shown to be dependent on the substitution pattern of the sugar moiety when using pyrimidines, leading to uracil/thymine-linked pseudodisaccharides or to products of mono-coupling.

Peracetylated glucuronamides were the glycosyl donors used for N-glycosylation of a nucleobase or a sulfonamide, or were converted into anomeric azides for further access to glycosyl phosphoramidates. Azide-alkyne “click” cycloadditions enabled the synthesis of glucuronamide-based hybrids containing both a benzyltriazole moiety and an anomeric sulfonamide or a phosphoramidate function, as potential nucleotide mimetics.

Biological assays revealed some compounds as good inhibitors of acetylcholinesterase (AChE) or exhibiting cytotoxic effects to tumor cells, with inhibition constants or IC_{50} values, respectively, in the micromolar concentration range. Molecular docking studies allowed inspecting the binding modes of the best AChE inhibitors to the enzyme.

The synthetic methodologies and the findings of the bioactivity evaluation will be revealed.

Acknowledgements

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[1] L. P. Jordheim, D. Durantel, F. Zoulim, C. Dumontet, Nat. Rev. Drug. Discov. 12 (2013) 447–464.
[2] M. Winn, R. J. M. Goss, K.-i. Kimura, T. D. H. Bugg, Nat. Prod. Rep. 27 (2010) 279–304.
[3] N. M. Xavier, S. Schwarz, P. D. Vaz, R. Csuk, A. P. Rauter, Eur. J. Org. Chem. 2014 (2014) 2770–2779.
[4] N. M. Xavier, S. D. Lucas, R. Jorda, S. Schwarz, A. Loesche, R. Csuk, M. C. Oliveira, Synlett 26 (2015) 2663–2672.
[5] D. Batista, S. Schwarz, A. Loesche, R. Csuk, P. J. Costa, M. C. Oliveira, N. M. Xavier, Pure Appl. Chem. (2016) DOI: 10.1515/pac-2016-0102.

Sustainable carbon materials AS support for oxidation catalysts

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Despite the greate number of studies focused on the immobilization of catalytically active metal complexes onto solid matrices this remains a hot research topic since the use of immobilized catalysts allows an ease separation of the reaction medium enabling sucessives reuses.

Inorganic materials, such as, silicas, clays or zeolites, and carbon materials, like carbon fibers, are among the most explored solids as catalyst support matrices. On the contrary, the use of activated carbons or other carbon materials prepared by less conventional methodologies is much more restricted. In this context the goal of this work is to test the potential of carbon materials obtained by acid hydrolysis of biomass followed by polycondensation [1], as catalyst supports.

A sisal derived carbon material was derivatized with a Mo complex – $[MoI_2(CO)_3(MeCN)_2]$ which binds to the surface of the carbon material with displacement of the labile acetonitrile ligands.

Materials were characterized by spectroscopic methods (FTIR, DRX), as well as SEM, TEM, thermogravimetry analysis, and N_2 adsorption at -196 °C.

Selective olefin epoxidation is a very important process as epoxides are relevant building blocks across many areas. The synthesized materials have been tested in oxidation catalysis of enantioselective epoxidation of olefins (*cis*-cyclooctene, styrene and R-limonene) with tertiary butyl hydroperoxide at 55 ºC in dichloromethane during 24 h. Results (conversions, yields and enantiomeric excesses) were analyzed by gas chromatography-mass spectrometry (GC/MS). Kinetic profiles reproduced in Fig. 1 exemplify the results obtained, showing that the carbon material does not hold any intrinsic catalytic activity towards epoxidation of *cis*-cyclooctene but, conversely, Mo-derivatized material showed high catalytic activity towards the epoxidation of this olefin.

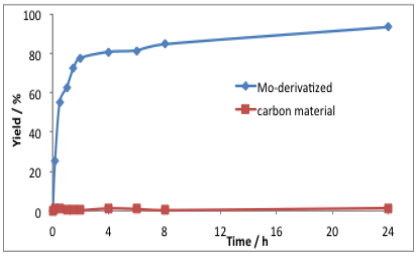

Figure 1. Kinetic profile for *cis*-cyclooctene epoxidation catalyzed by carbon material and Mo-derivatized catalyst.

Acknowledgements

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[1] L. Wang, Y. Guo, B. Zou, C. Rong, X. Ma, Y. Qu, Y. Li, Z. Wang, Bioresour. Technol., 2011, 102, 1947-1950.

Molybdenum(II) complexes as catalysts in reduction reactions

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Different molybdenum complexes from the family $[MoX(\eta^3\text{-}C_3H_5)(CO)_2(L)]$ were synthesised by reaction of the precursor $[MoBr(\eta^3\text{-}C_3H_5)(CO)_2(CH_3CN)_2]$ with different bidentate ligands (L) derived from 1,10-phenanthroline, as well as by substitution of the Br halide ligand with acetonitrile, pyridine or triflate. All new compounds prepared were characterized by FTIR, ^1H and ^{13}C NMR, as well as elemental analysis.

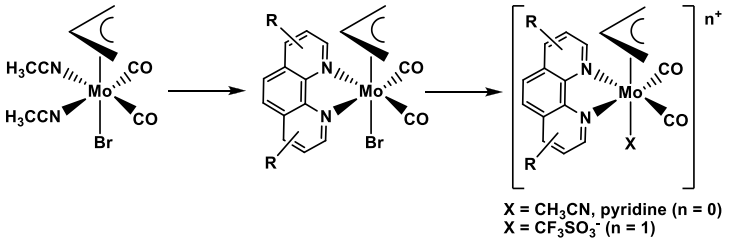

Figure 1. Complexes $[MoX(\eta^3\text{-}C_3H_5)(CO)_2(L)]$.

All the molybdenum(II) complexes were tested as catalysts in the reduction of two sulfoxides, methylphenyl sulfoxide and diphenyl sulfoxide. The reaction conditions were optimized by studying different reduction agents (triphenylphosphine and phenylsilane), co-catalysts ($NaBF_4$, KBF_4, $AgPF_6$), temperatures (room temperature, 55 ºC, 80 ºC and 100 ºC) and solvents (dichloromethane, chloroform, acetonitrile, tetrahydrofuran and toluene). All these studies helped to understand the influence of the different ligands on the complexes catalytic activity for reduction reactions. The best result was achieved with the precursor complex which presented 100% conversion after 3h.

Acknowledgements
We thank Fundação para a Ciência e Tecnologia for financial support (PEST UID /MULTI/00612/2013). MSS thanks FCT for Grant SFRH / BPD / 88082 / 2012.

[1] M.S. Saraiva, S. Quintal, F.M.C. Portugal, T.A. Lopes, V. Félix, J.M.F. Nogueira, M. Meireles, M.G.B. Drew, M.J. Calhorda, Journal of Organometallic Chemistry, 2008, 693, 3411.
[2] J.M.S.Cardoso, B. Royo, Chemical Communication, 2012, 48, 4944.
[3] I. Cabrita, S.C.A. Sousa, A.C. Fernandes, Tetrahedron Letters, 2010, 51, 6132.

Recovery of phenolic compounds from infusions: Antiacetylcholinesterase and antioxidant activity

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Infusions of leaves from plants or from peels of fruits is an easy and green way of obtaining compounds with biological activities, requiring only minor purification steps if a mixture of phenolic molecules is the main objective. In this work infusions from leaves and fruit of *Sambucus nigra* (Sabugueiro), Fig1 a, peels from *Annona cherimola*, Fig 1b was used to obtain phenolic compounds. The identification is under evaluation through LC-MS/MS. The antiacetylcholinesterase activity was determined for the non-purified extracts in the case of *S.nigra* and also for the purified peel extracts using DPPH method. The capacity to avoid the lipid peroxidation is also evaluated using the TBARs method. This activity is very important not only to provide, *in vitro*, the antioxidant activity that may happen in biological systems, as well as to develop new non-toxic antioxidants for the food industry. The biological activity of syrups from *S.nigra* are also under study. These syrups are highly recommended for flue and other ailments[1].

Figure 1: Materila used in this study; (a) *Sambuco nigra*; (b) *Annona cherimola* fruit peels

This is the work of 4 volunteers from the Biochemistry course.

Acknowledgements

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[1] A.Proença-da-Cunha, A. Pereira-da-Silva, O. Rodrigues-Roque. Plantas e Produtos Vegetais em Fitoterapia, Fundação Calouste Gulbenkian, 2003, p. 568.

Modelling halogen bonds in molecular dynamics simulations of bacteriophage T4 lysozyme

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Halogen atoms are commonly used in drug design to fill hydrophobic cavities in protein binding sites, improve blood–brain barrier crossing or facilitate membrane permeability. Besides these non-specific effects, halogens are able to establish directional, non-covalent interactions, known as halogen bonds (R-X···B, where X = Cl, Br, I and B = Lewis base). These bonds are explained by the existence of a positive region at the tip of the halogen atom, called σ-hole, which interacts with Lewis bases. Halogen bonds play an important role in protein-drug interactions and several structures deposited in the RCSB Protein Data Bank show this type of interaction, thus showing its potential for rational drug design. The implementation of halogen bonding in biomolecular force fields is not common and often relies on the use of massless points of charge to emulate the σ-hole. Despite its high popularity, the GROMOS force field does not contain such implementation.

Herein, we present a strategy to include halogen-bonding in the GROMOS 54A7 force field using the bacteriophage T4 lysozyme as a test case. Indeed, the X-ray structures of the bacteriophage T4 lysozyme [1] complexed with several C_6F_5X (where X = H, F, Cl, Br or I) and C_6H_5X (where X = H or I) molecules show evidence for I···S halogen-bonding. Molecular dynamics simulations of this protein bound to benzene or iodobenzene using the standard force field parameters will be compared with simulations performed with our halogen-bond capable implementation for iodobenzene.

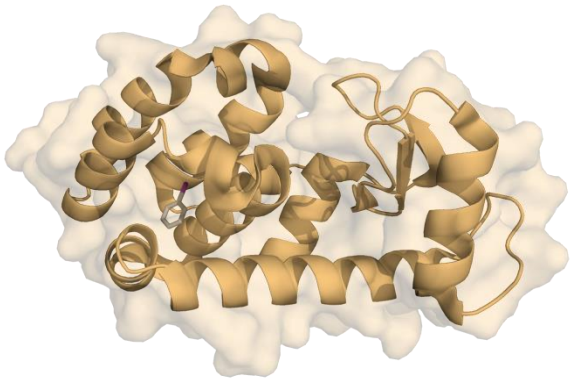
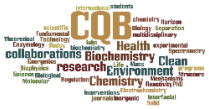


Figure 1. Iodobenzene bound in the hydrophobic cavity of T4 lysozyme (3DN4). Protein is shown in cartoon and iodobenzene is shown as sticks.

Acknowledgements
The authors thank FCT for financial support (UID/MULTI/00612/2013). PJC acknowledges FCT for the "Investigador FCT" Program (IF/00069/2014).

[1] L. Liu, W. A. Baase, B. W. Matthews, *J. Mol. Biol.* 385 (2009) 595.



Spontaneous incorporation of silver particles in thiophene-based conducting polymers

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Silver dispersions on polymer matrices are among the most studied hybrid systems involving electronically conducting polymers. The metal clusters formation may be carried out by electrodeposition [1], by electroless deposition[2] or, in the special case of polyaniline or polypyrrole, by electroless precipitation [1]. It is well known the capacity that those N-containing polymers have to spontaneously reduce noble metal ions in solution during its dynamic maintenance of the equilibrium [4,5]. Nevertheless, little is known about the mechanisms involved in metal spontaneous reduction by conducting polymers from other families. In this work a systematic study of the silver "electroless" reduction by conducting polymers from the family of thiophene is carried out.

Films of PTh (Polythiophene), P3MeTh (Poly(3-methylthiophene) and PEDOTh(Poly(3,4-ethylenedioxythiophene)) were electrosynthesized on platinum substrates and immersed, in the reduced or oxidized state, in silver containing solutions under open circuit conditions. The electrode potential was monitored during this process as well as the electrode mass variations by microgravimetry. The modified electrodes were characterized by cyclic voltammetry (before and after exposure to silver solutions) and by hi-resolution microscopy (SEM and AFM). The results point to a galvanic displacement of silver in all the polymers immersed in the neutral state, concomitantwith their spontaneous oxidation. However, after this initial process, the quartz crystal microbalance results show that electroless precipitation process occurs on the PEDOTh matrix. It allows an accumulation of higher amounts of the metal at the polymer surface as reflected by the voltammetric results of this hybrid system. Local elemental analysis clearly confirmed the presence of the silver clusters in all the polymers, with varying sizes as monitored by microscopy.

Acknowledgements
This work is funded by FCT (Fundação para a Ciência e a Tecnologia) through the project UID/MULTI/00612/2013

[1] SS Kim, SI Na, J Jo, DY Kim and IC Nah, App. Phys. Lett., 93 (2008) 073307.
[2] LM Abrantes and JP Correia, Electrochim. Acta, 45 (2000) 4179-85.
[3] YP Ting, KH Neoh, ET Kang and KL Tan, J. Chem. Tech. Biotechnol. 59 (1994) 31-6.
[4] A Mourato, AS Viana, JP Correia, H. Siegenthaler and LM Abrantes,Electrochim. Acta, 49 (2004) 2249-57.
[5] V Tsakova, Solid State Electrochem, 12 (2008) 1421-34.

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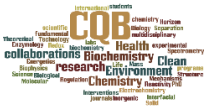

Mob1, hippo pathway member, is critical for *Toxoplasma gondii* replication

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Toxoplasma gondii is an obligate intracellular parasite of great veterinary and medical importance. It is able to evade the immune system of the host by converting from rapidly proliferating tachyzoites to latent bradyzoite cysts and this parasite number control is a key to the success of the infection. Pathways controlling cell division/proliferation like the Hippo pathway are likely candidates for regulating parasite replication. Human Mob1 participates in this pathway and our recent data suggests it is an excellent candidate in the control of parasite replication/number. Our research group has identified a single mob1 gene in *T. gondii*. A phylogenetic analysis of this gene showed it to be similar to other Apicomplexa but distant from protozoan parasites like the Trypanosomatida. We confirmed that this gene is expressed and our data show that its expression dramatically decreases (94%) during the parasite replication inside the host cell. We have constructed a transgenic parasite strain that overexpresses Mob1 and these parasites show a significant delay in the replication process. Using an in house polyclonal antibody against this protein we observed a very clear polarized localization of the protein in the parasite posterior pole, where the basal complex, a structure involved in cytokinesis in *T. gondii*, is localized. To better understand the role of *Toxoplasma* Mob1 we have created, by using the by CRISPR/Cas9 approach, a strain where Mob1 loss of function can be induced. Our preliminary results, by immunofluorescence microscopy, show that after induction *Toxoplasma* parasites in parasitophorous vacuoles (PV) lose their intrinsic polarity and their normal rosette organization. Indeed, inside of the PV it is difficult to identify the individual dividing parasites that seem to have originated a mass of abnormal cells where multiple nuclei are present. This result suggests that *Toxoplasma* cells have abnormal division and/or fail the cytokinesis. Altogether, the data support that Mob1 is involved in the control of *T. gondii* replication and is a promising candidate to target therapeutic agents against *Toxoplasma* parasites proliferation.

Acknowledgements

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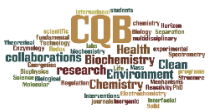

Resource allocation to maintenance and stress response: set up of a quantitative experimental model

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Saccharomyces cerevisiae (*S. cerevisiae*), used traditionally in the making of brewers and baking, is a eukaryotic unicellular organism able to grow rapidly in liquid media, making it the simplest model for the study of the eukaryotic cell. The aero-fermentative metabolism of this yeast presents some resemblance with the "Warburg effect" observed in some fast-proliferating cells, making the study of *S. cerevisiae* metabolism of vital importance.

A suitable tool for the study of yeast metabolism is *flow microcalorimetry* as it allows following in real-time the dissipated energy resulting mainly from the catabolism. We found that the dissipated heat associated to the cellular metabolic activity is dependent on the culture medium used. The maximum energy dissipated over time (power, P) obtained from the growth in 2% glucose in 3 different common media - YPD (Yeast Extract, peptone and dextrose), CAA (casein amino acids supplemented medium) and *Synthetic Complete* (SC) - was observed to be significantly higher in the rich medium YPD when compared to the less rich SC medium. Interestingly not only the maximum power changed but also the profile of the P over time; when grown in YPD or CAA, the power increases exponentially until reaching a maximum when occurs the switch from aerobic fermentation to respiratory metabolism and then returns to the baseline; when grown on SC medium the profile presents 2 peaks, the first possibly is caused by the depletion of one or multiple amino acids present in the synthetic medium resulting in a lower P and then a second peak similar to the other media is observed. The P per cell is maximal during the transition from lag to exponential phase but this maximum is higher in the (poor) SC than in a rich media like YPD. Interestingly, during the exponential phase, the P per cell is kept constant in YPD but not on SC, where it decreases continually. This analysis outlines the failure of SC medium, widely used in the selection of auxotrophic mutants in genetic approaches, to provide an unconstrained exponential growth. Unless strictly necessary, the use of SC media should be discouraged when studying the exponential phase as it is associated to a continuously shifting P per cell and, consequently, associated to a non-uniform growth phase.

To optimize exposure conditions to H_2O_2, the effects on the proliferative capacity of yeast cells were investigated. It was found that the killing kinetics of H_2O_2 follows a biphasic exponential decay: a first phase is observed immediately after the addition of 1 mM (lethal dose) H_2O_2 until 3 hours; a second phase follows where the population becomes more resistant to H_2O_2 and less cells die, when exposed to the same concentration of 1 mM, possibly due to adaptation to high concentrations of H_2O_2 or a bet-hedging mechanism. Similar results were observed when cell were previously adapted to H_2O_2, indicative that not all cells in the population become adapted in a typical adaptation protocol. Interestingly cells were able to resume their exponential growth even in the presence of such high concentrations of H_2O_2, implying an enhanced capacity to deal with the oxidative *stress*.

Finally, we studied the effect of non-lethal doses of H_2O_2 on the metabolism of growing *S. cerevisiae* via 3 *bolus* additions or a *steady state titration* over 90 min (same amount of H_2O_2 applied in both treatments). The P increased slightly immediately after the addition of H_2O_2 in both cases possibly as a result of increased catabolism over anabolism, necessary to the antioxidant response and adaptation. The exposure to the *steady state* is less harsher than with the 3 *bolus* additions since no difference in the heat produced was found compared to control in the first case but was higher in the second, meaning that the cells have to spend more resources to respond to the *bolus* exposure. The effect of several concentrations of H_2O_2 was also studied, observing an immediate decrease in P upon addition, associated with cell death, and a temporary arrest of the P-t curve, possibly associated with an adaptation response that was concentration-dependent, before resuming the typical growth.

Using *flow microcalorimetry* we demonstrate that *S. cerevisiae*'s metabolism is quite dependent on the culture medium and the nutrients contained in the media besides the carbon source, so that extra care must be taken when accessing for quantitative energy balances. Furthermore, the stress response is different depending on the type of administration (*steady state* or *bolus*) of the oxidant.

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Reorganization of plasma membrane lipid domains in *Neurospora crassa* during conidial germination

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Neurospora crassa, a haploid ascomycete, has been extensively used as a biological model for multicellular eukaryotes, namely in the study of developmental processes, apoptosis, aging and in the molecular basis of the circadian rhythm observed in asexual spore formation, conidiation. *N. crassa* cells have also been used for studies of resistance to antifungal drugs. *N. crassa* cells in the unicellular conidial stage have also ideal features to study sphingolipid (SL)-enriched domains. In this work, two fungal strains in the conidial stage (**Figure 1**), the wild-type (WT) and slime, which is devoid of cell wall, were studied, with different growth times, to evaluate how much their membrane biophysical properties are dynamic and relate with cellular stage. For a thorough biophysical characterization, detecting several types of domains and how they may differ in abundance and organization, the plasma membrane of *N. crassa* was labeled with three fluorescent membrane probes and several photophysical parameters measured, including fluorescence anisotropy and lifetimes, sensitive to distinct biophysical properties were measured. They were also compared with the unicellular fungus *S. cerevisiae*, one of the most widely studied eukaryotes, which has a plasma membrane with high ergosterol levels, whereas *N. crassa* conidia are practically devoid of ergosterol. Conidial growth of *N. crassa* was accompanied by membrane reorganization, namely increase of membrane fluidity, which occurs faster in the supplemented medium (SeM), needed for slime cells growth, than in minimal Vogel's medium (MMV). Gel-like domains, likely enriched in SLs, were found in both *N. crassa* strains. Those domains were particularly compact, rigid and abundant in the case of slime cells, even more than those occurring in *Saccharomyces cerevisiae*. Our results with *N. crassa* suggest that the melting temperature for SL-rich domains occurs near the growth temperature (30 ºC) for WT, but at higher temperatures for slime, as previously observed for *S. cerevisiae*. Regarding biophysical properties strongly affected by ergosterol, the slime plasma membrane displays more similarities to *N. crassa* WT than to *S. cerevisiae* cells. The differences encountered during this study gave us new insights about the plasma membrane organization and structure of *N. crassa* strains, and led to a better understanding of the relationships between its lipid composition and dynamics during conidial growth.

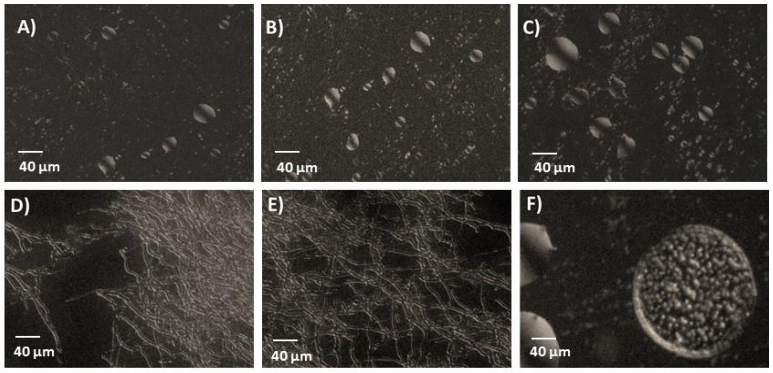

Figure 1. Transmission microscopy images for *N. crassa* WT and slime cells at different phases of growth. WT cells in MMV at 5 h (A) and 12 h (D) of growth; WT cells in SeM at 5 h (B) and 12 h (E) of growth; slime cells at 5 h (C) and 12 h (F) growth), with a magnification of 100×.

Acknowledgements

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Insecticidal activity of tropical and subtropical plant essential oils against *Aedes aegypti* larvae

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The use of plants for insect control has increased worldwide, with particular emphasis on search of essential oils (EOs) [1-3]. The emergence and re-emergence of vector-borne diseases, the increasing resistance to chemical insecticides, adverse effects on the environment, among others, it is become crucial to search for new insecticides compounds from natural or synthetic sources. In this perspective, we present the study of the larvicidal property of *Foeniculum vulgare* Mill. and *Mentha pulegium* L., from Cape Verde and Portugal, against *Aedes aegypti* Linnaeus 1762, the main vector of dengue (urban cycle).

EOs were obtained by hydrodistillation of *F. vulgare* and *M. pulegium* aerial parts. The chemical composition of all EOs from Portugal and Cape Verde were analysed by GC, GC-MS and ^{13}C NMR. EOs were assayed against *Aedes aegypti* third instar larvae [4]. A dose-mortality effect was observed, allowing the determination of the LC_{50}, LC_{90} and LC_{99} by probit regression analysis [5].

Pulegone (61%) and menthone (20%) were the main EO constituents isolated from *M. pulegium* collected in Portugal, while menthol (30%), menthone and menthyl acetate (15% both), and pulegone (4%) dominated Cape Verde EO. Conversely, the EO compositions from *F. vulgare* collected at Cape Verde and Portugal were similar. *trans*-Anethole (32 and 30%), limonene (28 and 18%) and fenchone (10% both) were the main compounds identified in Cape Verde and Portugal EOs, respectively.

The EOs of these plants showed strong larvicidal activity 24h after exposure. This study reveal that the larvae of *Ae. aegypti* have increased susceptibility to the *F. vulgare* EOs from Cape Verde, which can be correlated with the highest percentage of the stereoisomers of limonene (LC_{50} and LC_{90} = 13.0 = 23.2 µl L^{-1}) [4].

This study allowed the chemical characterization and activity assessment of plants from two different geographic countries that were not studied before with highly promising results.

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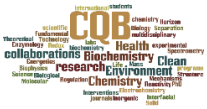
References:

[1] E. L. L. Baldin, A. E. M. Crotti, K. A. L. Wakabayashi, J. P. G. F Silva, G. P. Aguiar, E.S. Souza, R.C.S. Veneziani, M. Groppo, J. Pest Sci. 86 (2013), 301.
[2] A. Ali, N. Tabanca, B. Demirci, E. K. Blythe, Z. Ali, K. H. C. Baser, I. A. Khan, J. Agr. Food Chem. 63 (2015), 447−456.
[3] S. Tennyson, D. A. Samraj, D. Jeyasundar, K. Chalieu, Middle-East Journal of Scientific Research 13 (2013) 64-68.
[4] Rocha D. K.**,** Matos O., Novo M.T., Figueiredo A. C., Delgado M. & Moiteiro C. *Natural Product Communication*, 10 (2015) 677-682.
[5] WHO (1998). WHO Geneva, Switzerland (28-30 September).



Preparation and physicochemical and structural characterization of natural deep eutectic solvents

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In recent years there has been a huge interest in the preparation of ionic liquids (ILs). More recently, the study of eutectic solvents proposed as new "green" solvents for application in many chemical processes, including extraction and synthetic processes, has also been in great expansion.

Eutectic solvents are mixtures of compounds which have a melting point much lower than its individual components due mainly to the formation of strong intermolecular forces. These solvents show clear advantages in relation to ILs because they are easier to prepare with high purity and at a lower cost, and also because, in general, they have a low or even null toxicity. Melting temperatures can go down to at least -12 °C, and this trend is accompanied by high boiling temperatures and therefore low volatility which increases significantly the range of practical applications [1, 2].

However, despite the undeniable interest of these solvents, much remains to be done, in particular in terms of their accurate physicochemical and structural characterization. In this work the preparation and characterization of a set of choline chloride/ethylene glycol mixtures was performed. This characterization was achieved in terms of several properties, namely, electrical conductivity, polarity, density, surface tension and viscosity, at several temperatures.

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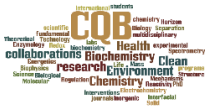
[1] E.L Smith, A.P Abbott, K.S Ryder, Chem. Rev. 114 (2014) 11060-11082.
[2] Y. Daia, J. Spronsenb, G-J. Witkampb, R. Verpoortea, Y. H. Choia, Anal. Chim. Acta 766 (2013) 61-68.



Personalised ICT supported service for independent living and active ageing: The contribution of functional ingredients and the website nutriageing

Alice Martins [a*], **Marta Sousa Silva**[a], **António Ferreira**[a], **Luís Sousa**[a], **Catarina Dias**[a], **Ana Marta Matos**[a], **Vasco Cachatra**[a], **Daniela Batista**[a], **Antónia Turkman**[b], **Feridun Turkman**[b], **Marília Antunes**[b], **Helena S. Costa** [c], **Tânia Albuquerque** [c], **Ana Sanches**[c], **Amélia P. Rauter**[a]

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Development of a new service model, to screen for and prevent frailty in older adults, covering nutrition, physical and cognitive domains, has been successfully accomplished with the participation of a multidisciplinary team from five countries, namely Portugal, Spain, Italy, Ireland, and The Netherlands and supported by the European Union under the FP7 program. This communication describes the work developed within the workpackage under the leadership of the Portuguese team, in particular regarding the creation of the innovative NUTRIAGEING website (nutriageing.fc.ul.pt), co-sponsored by IUPAC and by the Lisbon Municipality. It is a unique platform for the transfer of scientific knowledge into advice to the general public. It offers several modules to promote healthier nutrition and to educate the population on how to improve rational food habits. It is structured around healthy eating, cooking recipes with videos, and how to grow a vegetable garden, as a source of cheap and functional food ingredients. Announcing the latest findings reported on the literature, the scientific knowledge offered is complemented by research developed within the Carbohydrate Chemistry Group at CQB on the medicinal plants *Genista tenera*, *Salvia sclareoides* and *Erica australis.* Their non-toxic active principles with antidiabetic, anticholinesterase, anti-inflammatory and antioxidant properties will also be presented and discussed.

Acknowledgements

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Synthetic cobalt clays for the storage and slow release of therapeutic nitric oxide

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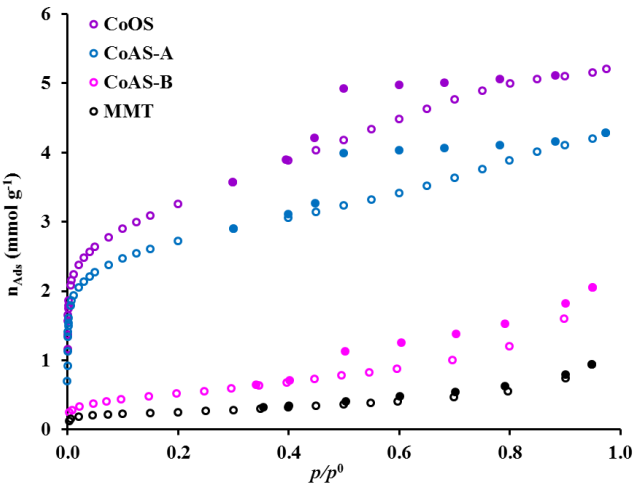
Nitric oxide (NO) is one of the smallest endogenous molecules with particularly interesting roles in biological systems, despite its toxicological potential. [1] Solid carriers have potential biomedical interest in the delivery of exogenous NO for anti-bacterial, anti-thrombic and wound healing applications. [2, 3]

In this work, a smectite clay was successful synthetized with incorporated cobalt ions in its structure, with the main goal of studying its potential in the field of storage and release of nitric oxide for therapeutic applications. Materials were characterized by X-ray diffraction (Philips PW 1730 diffractometer, nitrogen adsorption at -196 ºC (Micrometrics, ASAP 2010), DLS (Zetasizer Nano ZS, Malvern Instruments) and chemical analysis of cobalt contents were obtained by Atomic Absorption Spectroscopy of digested samples using a Unicam 929 (ATI UNICAM) spectrophotometer.

The nitrogen adsorption-desorption isotherms (Fig. 1) show a high specific surface area, as recorded in Table 1, which is the result of a finely divided structure. In this table there are also the values of basal spacing (d_{001}).

The kinetic data for the nitric oxide storage and release was obtained in gas and liquid phases, as recorded in Table 1. The released amounts of NO in the liquid phase were within the biological range and slow release kinetics with a near direct relationship between the released fraction and time was observed. Toxicological assays with HeLa cells indicated that the materials have low cytotoxicity.



FFFig. 1 Nitrogen adsorption-desorption curves at -196 ºC

Table 1 – Textural parameters.

	$d_{(001)}$ (Å)	A_{BET} (m^2g^{-1})	$[NO]_G$ (mg_{NO}/g_{solid})	$[NO]_L$ ($\mu g_{NO}/g_{solid}$)
MMT	12.6	20	2.1	8
CoAS-A	14.2	218	8.0	16
CoAS-B	11.9	41	8.5	47
CoOS	13.0	246	6.9	33

Acknowledgements
The authors thank the Foundation for Science and Technology for funding CQB UID/MULTI/00612/2013 and CERENA (UID/ECI/04028/2013) and for the grant SFRH/BD/72058/2010 (ACF).

[1] R.E. Morris, P.S. Wheatly, Angew. Chem. Int. Ed, 47 (2008) 4966-4981.
[2] M.L.Pinto, J. Rocha, J.R. Gomes, J. Pires, J. Am. Chem. Soc., 133 (2011) 6396-6402.
[3] A.C. Fernandes, M.L. Pinto, F. Antunes, J. Pires, J. Mater. Chem. B, 1 (2013) 3287-3294.

Metal-organic frameworks as potential nitric oxide storage and delivery vehicles for therapeutic applications

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Metal Organic Frameworks (MOFs) have generated intense interest due to their potential application in adsorption of gases and, depending of the chemical composition and toxicity, these materials may become potentially suitable for biomedical applications [1, 2]. In this work, non-toxic MOFs composed with Ni and Co ions and nicotinic acid as linker were designed to adsorb, store and release a controlled amount of nitric oxide (NO). The delivery of NO in therapeutic amounts would be an attractive alternative in several different areas (anti-thrombosis, dermatology and wound healing, anti-bacterial, vasodilation etc.) [2, 3].

The kinetic studies of adsorption and release of NO were performed in both gas and liquid phases using a microbalance associated with a high-vacuum system and using the oxyhemoglobin assay [4], respectively. The toxicity of the materials with and without NO-loaded was also evaluated using HeLa cells and primary human epidermal keratinocytes (HEKn).

According to the kinetic adsorption profiles (Figure 1), MOFs feature good gas storage properties, being possible to load up to approximately 7% (w/w) of NO inside, in less than 27h. The NO release studies in gas phase were indicative of total release in 24h and the same study in liquid phase revealed a controlled release over time.

The preliminary results of toxicology (Figure 2) are very encouraging for both materials (mainly for MOF with Ni), even using an elevated concentration (450µg/mL).

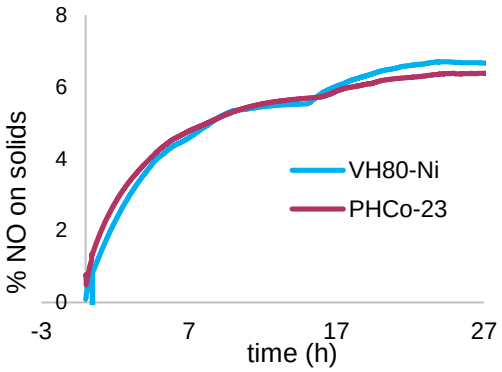

Figure 1 - Kinetic profiles of NO adsorption.

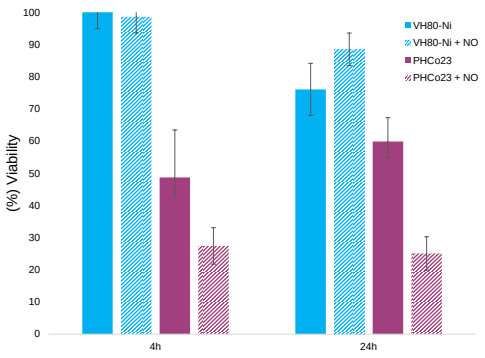

Figure 2 – HeLa viability after 4h and 24h.

Acknowledgements
Thanks are due to FCT by PEST UID/MULTI/00612/2013 (CQB) and UID/ECI/04028/2013 (CERENA) and Investigador FCT project IF/0093/2012/CP0172/CT0013.

[1] G. Ferey, *Chem. Soc. Rev.*, vol. 37, no. 1, pp. 191–214, 2008.
[2] N. J. Hinks, A. C. McKinlay, B. Xiao, P. S. Wheatley, and R. E. Morris, *Microporous Mesoporous Mater.*, vol. 129, no. 3, pp. 330–334, 2010.
[3] A. C. Fernandes, M. L. Pinto, F. Antunes, and J. Pires, *J. Mater. Chem. B*, vol. 3, no. 17, pp. 3556–3563, 2015.
[4] M. Feelisch, D. Kubitzek, and J. Werringloer, *Methods nitric oxide Res.*, pp. 455–478, 1996.

Capture and activation of CO_2 by metal-organic structures

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Currently hydrocarbon fuels are the most important source of energy because of their ready availability, stability, and high energy density. The increasing atmospheric concentration of CO_2 has been predicted by models which suggest dramatic and irreversible changes if actions are not taken urgently. It is now well established that CO_2 may be sequestered and stored as liquid CO_2 or solid carbonate but both solutions are energetically demanding and financially costly [1]. Recently reports of reaction of pressurised CO_2 with epoxides to form polycarbonates [2] or cyclic carbonates [3] have attracted both academic and industrial interest, but generally, the recycling of CO_2 to produce high value products via low-cost catalysts has not been exploited. Nelson's cryptands [4] are an example of a dynamic structure with useful applications, which demonstrated the ability to capture and convert CO_2 to carbonate and methyl carbonate following its coordination to encapsulated metal ions. Here we explore the fixation chemistry of CO_2 by derivatised dinuclear Cu(II), Ni(II), Zn(II) and Co(II) cryptands (Figure 1) where the phenyl ring was modified towards engineering these metal-organic structures into supramolecular assemblies. Attaching electron withdrawing groups to the phenyl ring proved to not affect their ability to capture CO_2.

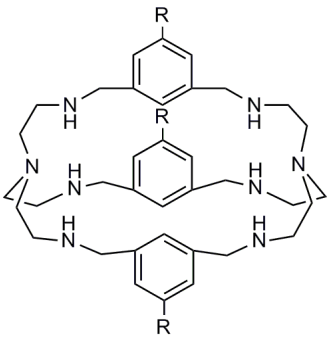

Figure 1 Derivatised cryptands.

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[1] O.D. Bert Metz, Heleen de Coninck, Manuela Loos and Leo Meyer in: Carbon Dioxide Capture and Storage, UK, 2005, 431.
[2] G.W. Coates, D.R. Moore, Angew. Chem. Int. Ed., 2004, 43, 6618.
[3] J. Meléndez, M. North, R. Pasquale, Eur. J. Inorg. Chem., 2007, 3323.
[4] Y. Dussart, C. Harding, P. Dalgaard, C. McKenzie, R. Kadirvelraj, V. McKee, J. Nelson, J. Chem. Soc., Dalton Trans., 2002, 1704.

Phenolic quantification in different *Camellia sinensis* infusions and relation with their antioxidant activity

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Camellia sinensis is a plant largely consumed all over the world, Fig. 1. This plant can be subject to different treatments giving different types of beverages[1]. The leaves can be used soon after being collected (green tea) or after being fermented (black tea). A new variety is the use of young leaves to prepare a different infusion (white tea). These dissimilar procedures of preparing the leaves, originate different tastes in the final beverage, due, in part to different content and different type of phenolic compounds[1]. These beverages can even be consumed with other liquids like lemon juice or milk, for instance. The objective of this work is the quantification of total phenolic in these different beverages and its correlation with the antioxidant activity and to explain why the black tea changes its colour with the addition of lemon juice. The identification of the phenolic compounds will be carried out by LC-MS/MS and is under evaluation. Phenolics in the infusions as well as its antioxidant activity is indicated in Table 1. This is a small research project from students of the 3rd year of the Chemistry degree.

Figure 1: *Camellia sinensis*

Table 1: Total phenols (equivalent μg of gallic acid/mg of infusion) and antioxidant activity measured as DPPH extinction percentage (μg of extract/mL)

	Total phenols (gallic acid equivalent)	Antioxidant activity (DPPH)
Black tea	257.2±88.2	0.41 ± 0.07
Green tea	290.1±73.1	0.34 ± 0.17
White tea	97.2±25.8	-
Black tea Yorkshire	298.0±80.0	18.4 ± 1.16
Black tea Yorkshire with lemon juice (100 mL)	666.0±70.0	8.48 ± 1.31

Acknowledgements

FCT for the programmatic financing reference number: UID/MULTI/00612/2013

[1] Y.Hilal, U. Engelhardt, J. Verbr. Lebensm. 2 (2007) 414 – 421.

Development of lysosomal-mimicking vesicles to study the effect of sphingosine abnormal accumulation on membrane biophysical properties

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Sphingosine (Sph) is one of the simplest lipids and one of the most prevalent backbones of sphingolipids in mammals. This lipid plays important bioactive roles in different cellular processes and has been implicated in Niemann Pick type C1 (NPC1), a complex lysosomal storage disease. To understand how the accumulation of this lipid in NPC1 impacts lysosomal membrane structure and biophysical properties, we developed lysosomal-mimicking vesicles displaying internal acidic pH and external neutral pH. Moreover, the lipid composition of the vesicles was modified in order to resemble physiological- or NPC1-like lysosomes. To this end, ternary 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphocholine (POPC)/Sphingomyelin (SM)/Cholesterol (Chol) mixtures with, respectively, low and high Chol/SM levels were prepared. The effect of Sph on the membrane permeability and biophysical properties was then evaluated by fluorescence spectroscopy, electrophoretic and dynamic light scattering. Our results showed that Sph has the ability to cause a shift in vesicle surface charge, increase the packing properties of the membrane and promote a rapid increase in membrane permeability. These effects are enhanced in NPC1-lysosomal-mimicking vesicles, i.e., containing higher levels of Chol and SM. These results suggest that lysosomal accumulation of these lipids, as observed under pathological conditions, might significantly affect lysosomal membrane structure and integrity, and therefore contribute to the impairment of cell function.

Acknowledgements
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Interaction of *D*-glucose end-capped polylactide ruthenium cyclopentadienyl complexes with GLUT: insights from molecular docking

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D-glucose end-capped polylactide ruthenium cyclopentadienyl complexes (RuPMC) show promising cytotoxic activity against several human cancer cells (IC_{50} values in the μM range [1, 2] and the sugar moiety in these complexes opens the possibility for a GLUT-mediated mechanism of cellular uptake. Indeed, most mammalian cells import glucose by a process of facilitative diffusion mediated by members of the GLUT family of membrane transport proteins. [3] In particular, GLUT1 is the most common glucose transporter, being overexpressed in many human cancers [4] thus providing a suitable target for cancer therapy.

In the last few years, pharmaceutical companies have been using *Virtual Screening* techniques, in particular, molecular docking, [5] in order to identify and select compounds able to bind a specific target. Docking techniques were also employed in the understanding of GLUT-mediated cellular uptake of carbohydrate-appended [(η^5-C_5H_5)Ru(N-N)(PPh_3)][PF_6] complexes. [6]

Given the promising nature of these RuPMC complexes, we used molecular docking in order to try to understand their interaction with GLUT1. Model complexes were built varying the length of the polymer chain (see Figure 1, left) and were docked on the cavity of the bacterial xylose transporter XylE (PDB: 4GBZ), a GLUT1 homolog which was solved in an outward-open conformation thus providing a reasonable initial model for the scenario a given molecule encounters when entering a cell. Our docking results show that XylE is able to recognize the *D*-glucose moiety of the complex and that the size of the polylactide chain is important.

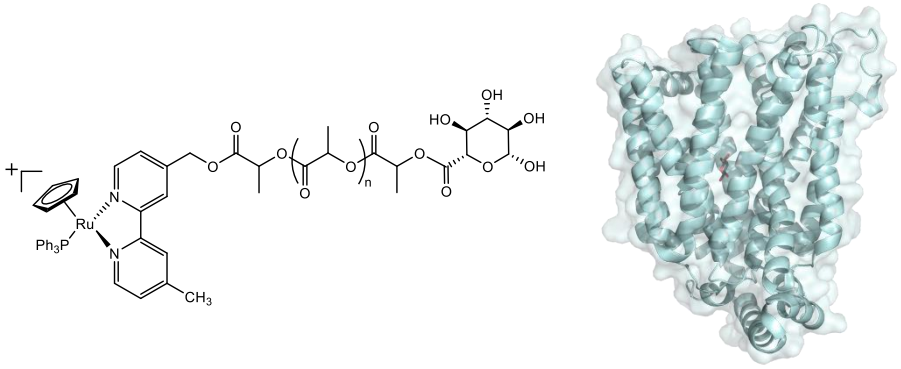

Figure 1. Left: D-glucose end-capped polylactide ruthenium cyclopentadienyl complexe (RuPMC) model; right: crystal structure of a bacterial homologue of glucose transporters GLUT1 bound to D-glucose.

Acknowledgements
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[1] A. Valente, M.H. Garcia, F. Marques, Y. Miao, C. Rousseau, P. Zinck, *J. Inorg. Biochem.* 127 (2013) 79-81.
[2] M.H. Garcia, A. Valente, T.S.F Morais, A.I. Tomaz, Patent application PCT/IB2015/002312.
[3] B. Thorens, M. Mueckle, *Am. J. Physiol. Endocrinol. Metab.* 298 (2010) E141–E145.
[4] L. Szablewski, *Biochim. Biophys. Acta Rev. Cancer* 1835 (2013), 164.
[5] Kitchen *et. al. Nat. Rev. Drug Discov.* 3 (2004) 935-949.
[6] P.R. Florindo, D.M. Pereira, P.M. Borralho, P.J. Costa, M.F.M. Piedade, C.M.P. Rodrigues, A.C. Fernandes, *Dalton Trans*. 2016, Accepted (DOI: 10.1039/C6DT01571A)

Using solvatochromic probes for the study of intermolecular interactions in 1,4-dioxane/methanol/acetonitrile solvent mixtures

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Mixtures of different compositions were prepared for the binary systems 1,4-dioxane/acetonitrile and 1,4-dioxane/methanol (9 mixtures each) and for the ternary system methanol/1,4-dioxane/acetonitrile (22 mixtures), in a total of 40 mixtures.

UV-Vis absorption spectra were obtained at 298.15 K for five solvatochromic probes, namely betaine (30), 4-nitrophenol, 4-nitroanisole, 4-nitroaniline and *N*,*N*-dimethyl-4-nitroaniline. Preferential solvation was studied using the Bosch and Rosès model for the binary mixtures [1], and an extension of the model for the ternary mixture [2], allowing the establishment of the preferential solvation order for all species present in solution, including solvent "complexes" [3].

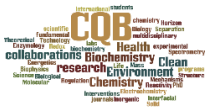
The applied model enabled the identification of synergistic behaviors in 1,4-dioxane/methanol and 1,4-dioxane/acetonitrile mixtures and therefore to conclude about the existence of solvent "complexes" in solution. No synergism was detected in the ternary system, where the behavior reflected a combination of the contributions of the underlying binary systems.

Kamlet-Taft solvent parameters π^*, α and β, were also calculated for all mixtures and their variation with composition carefully scrutinized.

The addition of small amounts of 1,4-dioxane to the mixtures was seen to cause a considerable variation in π^*. Additionally, in dioxane rich mixtures an accentuated effect in α was observed which was especially visible in the dioxane/methanol mixture.

Acknowledgements
The authors are grateful to Fundação para a Ciência e a Tecnologia, Portugal, for financial support under projects PEst-OE/QUI/UI0612/2013 and UID/MULTI/00612/2013.

[1] E. Bosch, F. Rived, M. Rosés, J. Chem. Soc. Perkin Trans 2 (1996) 2177-2184.
[2] N. Nunes, C. Ventura, F. Martins R. Elvas-Leitão, J. Phys. Chem. B 113 (2009) 3071-3079.
[3] N. Nunes, R. Elvas-Leitão, F. Martins, Spectrochim Acta A 124 (2014) 470-479.



Glycoside antibiotics and mechanism of action

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The present work aimed to investigate the mechanism of action (MoA) of dodecyl 2,6-dideoxy-α-L-*arabino*-hexopyranoside, one of the most active compounds within a family of alkyl glycosides, previosuly discovered by our research group, that exhibited a potent antimicrobial activity against *Bacillus* species, in particular *Bacillus cereus* and *Bacillus anthracis*. Firstly, its antibacterial properties were assessed in vegetative and spore cells and the characteristics of the bactericide activity shown were identified, including the total absence of resistance to this compound even after long exposure.

Compound impact on the bacterial vitality, viability and bacterial metabolism was studied, providing guidelines for the forthcoming studies. Genetic dissection was carried out by random transposition and knock-out of specific membrane related targets.

Given the results obtained, the effects of the compound in different cellular ultra-structures were studied and finally observed by atomic force microscopy.

This study confirms that the mechanism of action of this family of compounds does not rely on molecular interactions with target enzymes, suggesting that membrane interactions should play a role in the selective antimicrobial events observed.

Acknowledgements

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Biocidal microcapsules: a new strategy for biofouling control

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The adhesion and growth of micro/macroorganisms on surfaces in contact with water, is one of the most serious problems in water-based systems (e.g. shipping, water purification units, etc.). This undesired bio-attach, known as biofouling can promote substrate deterioration, systems clogging and fluids contamination, resulting on costly maintenance and retrofitting consequences. For instance, on shipping industry the biofouling accumulation on ships hulls can lead to drag friction increases up to 40% and subsequent fuel consumption and Greenhouse gas emissions increases [1]. The most efficient and conventional methods to control biofouling are mainly based on a chemical strategy. They comprise the direct and/or controlled releasing of biocides into the contaminated surface. Most of them employ coatings incorporating biocides which act by a controllable releasing mechanism. However, the main drawback of those systems is the poor control on biocides releasing and the potential degradation of those agents in the coating matrix. This leads to a reduction on the antifouling action of the coating, and thus on its lifecycle. Alternatively, higher biocides content can be used to achieve the required lifetime, but the continued release of those toxic agents into the environment has proven to cause serious side effects on ecosystems [2]. Environmental friendly technologies are therefore sought.

In this work, biocidal polyurethane-polyurea microcapsules (MC´s) able to provide a more controllable biocidal action, by promoting partial/total biocide immobilization on MC's shell have been developed. Water-in-oil (W/O) microemulsion method combined with interfacial polymerization has been used for the purpose. Two main innovative strategies for the MC's synthesis were followed: i. the microencapsulation of a biocide (Econea) in the MC's core, together with its chemical immobilization in the MC's shell; ii. and, the chemical immobilization of the biocide in the MC's shell, by using prior modified biocides [3]. Optical microscopy images obtained for the developed MC's show that the first strategy leads to better MC´s in terms of their morphologic properties, i.e, well-defined shape and size uniformity. Degradation of their morphology was shown to occur for higher contents of the binding biocide in the MC's shell. FTIR analysis evidenced that the MC´s shell composition depends on the MC's core composition (water + surfactant) and biocide type and content. Higher water contents were found to promote polyurea formation within the shell. MC's bioactivity has been assessed using *Staphylococcus aureus* (ATCC 25923) bacteria within different mediums (artificial seawater, DMSO and *MilliQ* water). All developed MC´s, from both strategies, proved to possess bioactivity. The best results in terms of morphological MC's properties and bioactivity were found for MC´s prepared from the first strategy and with biocide contents as high as 20 wt.%.

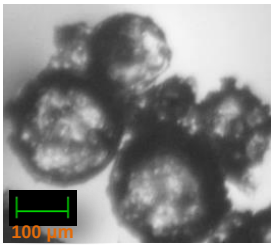

Figure 1. Biocidal microcapsules with 20 wt%. biocide.

As a proof of concept, MC´s with 20 wt.% of biocide obtained from both strategies were incorporated in a marine polyurethane paint to coat acrylic substrates. Similar bioassays performed on those prototypes, evidenced a similar bioactivity for both MC's types. Leaching tests and antifouling assessment at simulated (aquarium) and real conditions (seawater) are in progress to better understand the involved antifouling action, i.e., bioactivity due to biocide leaching or by contact, or both.

Acknowledgements
The authors acknowledge the financial support from FCT through SFRH/BPD/88135/2012, SFRH/BPD/96697/2013 and UID/MULTI/00612/2013. The authors also thank HEMPEL A/S for the marine paint providing.

[1] B. Dahlbäck, H. Blanck, M. Nydén, Cost. Mar. Sci. 34 (2010) 212-215.
[2] T. R. Bott, Industrial Biofouling, first ed., Elsevier, United Kingdom, 2011.
[3] E.R. Silva, O. Ferreira, J. C. Bordado, PCT application, PT2015/000050 (108096), 2015.

Biomembrane organization: Biophysical characterization of ordered domains

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The present work aims the biophysical study of the coexistence of membrane ordered domains, namely gel (so)/liquid-ordered (lo) phases, in membrane model systems of POPC/PSM/Chol. This system contains the main components of mammalian plasma membrane, and the corresponding phase diagram is already known **(Figure 1)** [1]. Different approaches have been utilized, including time-resolved and steady-state fluorescence measurements, using di-12-ANEPPQ probe labelling liposome suspensions, and solution Atomic Force Microscopy (AFM), to visually detect lateral organization and topographic features in three-component lipid membranes supported by mica substrate [2].

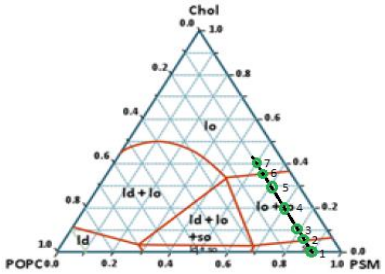

Figure 1- 1-palmitoyl-2-oleoyl-*sn*-glycero-3-phosphocoline (POPC)/ *N*-palmitoyl-sphingomyelin (PSM)/ cholesterol (Chol) lipid phase diagram used in the study of coexistence of membrane ordered domains. So/lo tie-line is represented by the black line. The lipid mixtures used in the fluorescence measurements are represented by the green circles numbered from 1 (5 mol% chol) to 7 (40 mol% chol). Adapted from reference [1].

Fluorescence-based techniques reveals peaks at 470 nm and 635 nm, for excitation and emission spectra, respectively, in both pure POPC (liquid-disordered (ld)) and pure DPPC (so) membranes. However, a blue shift occurs in emission spectra, along a ternary so/lo tie-line **(Figure 1)**, as well as an increased fluorescence intensity, with profiles that are totally consistent with the so/lo phase boundaries predicted in the phase diagram of **Figure 1**. These results were accompanied by a decrease of steady-state fluorescence anisotropy of di-12-ANEPPQ, suggesting a lower lipid/water interfacial order in lo membranes. The time-resolved fluorescence data reveals three different fluorescence lifetime components, and the mean fluorescence lifetime values of di-12-ANEPPQ are longer for lo membranes.

The membrane/water partition coefficient (Kp) of di-12-ANEPPQ for ld, lo, and so domains was also estimated plotting the intensity values against lipid concentration [3]. The results suggest that di-12-ANEPPQ tends to partition preferentially into an ld phase, but has higher quantum yield in lo phase.

Finally, AFM images reveals the presence of two types of lipid domains for membranes of POPC/PSM/Chol (1:7:2 molar ratio) **(Figure 1**-circle 4**)**. For this lipid composition, domain splitting and thinning were observed, as well as a thickness difference of ca. 1.7nm – 0.9 nm between the two observed domains. It is expected that the more ordered and thicker domains are largely sterol-free and composed mainly by the highest T_m lipid (PSM) [4], as suggested by previous studies *in vivo* using *Saccharomyces cerevisiae* [5].

Acknowledgements
Fundação para a Ciência e a Tecnologia (FCT), Portugal is acknowledged for PTDC/BBB-BQB/6071/2014, PEst 2015-2020 (UID/Multi/00612/2013) and IF2012/2013 initiatives (P.O.P.H., F.S.E.). T. M. Paiva acknowledges fellowship under grant n. IF/00808/2013/CP1159/CT0003.

1. de Almeida, R.F.M. and E. Joly,. Front Plant Sci, 2014. **5**.
2. Goksu, E.I., et al., Biochim Biophys Acta, 2009. **1788**(1): p. 254-66.
3. Bastos, A.E., et al.,. Chem Phys Lipids, 2012. **165**(5): p. 577-88.
4. de Almeida, R.F.M., A. Fedorov, and M. Prieto, Biophysic J, 2003. **85**(4): p. 2406-2416.
5. Aresta-Branco, F., et al., J Biol Chem, 2011. **286**(7): p. 5043-54.

Study of the permeability of phenolic compounds present in cladodes of *Opuntia ficus indica* and their effect on the cholesterol permeability through Caco-2 cell lines

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Currently one of the strategies used to improve health is the use of medicinal plants as functional foods due to their have medicinal properties, nutritional value, and pharmacological activities such as antioxidant, antithrombotic, anti-inflammatory, antiartherogenic, and cardioprotective effects [1,2]. Lots of these studies report a positive correlation between consumption of plant foods rich in phenolic compounds (i.e. flavonoids) and a reduction of the risk to suffer from degenerative diseases. One of these foods is *Opuntia ficus indica* cladodes (nopal), it is a member of *Cactaceae* family. Several studies have reported that nopal exerts beneficial effects on health. In fact, cladodes are used for treating arteriosclerosis, diabetes, gastritis and hypercholesterolemia [3,4]. The aim of this work was to study the permeability of the different aqueous extracts from cladodes of *Opuntia ficus indica* through caco-2 cell lines. The effect of these extracts on the permeability of cholesterol was also studied. The study of toxicity on Caco-2, HepG2 and MCF-7 cells of all the aqueous extracts showed no toxicity against the **1** *Opuntia ficus indica* 3 types of cell lines. The permeability of the different compounds present in cladodes' extracts was between 5,3 and 15,6%. For the main compound, piscidic acid (identified by LC-MS/MS), the permeability was between 9,7 and 11,3%. Mixed with cholesterol, the extracts showed a reduction on the cholesterol permeability. The permeability of cholesterol in presence of cladodes extracts was between 10 times and 20 times less than the permeability of cholesterol in absence of extracts.

Figure 1: *Opuntia ficus indica*

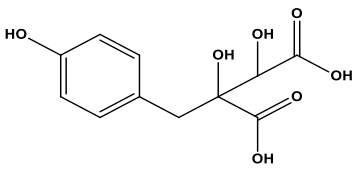

Figure 2: piscidic acid

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[1] J. A.Vinson, et al., J.Agric. Food Chem. 43: (1995) 2800–2802.
[2] C. Manach et al. Curr. Opinion Lipidol.,16 (2005) 77–84.
[3] E.M. Galati, et al. Pharm. Biol. 41 (2003) 175–179.
[4] A. Trejo-González, et al. J. Ethnopharmacol. 55 (1996) 27–33.

Multifunctional luminescent spin labile hybrid materials

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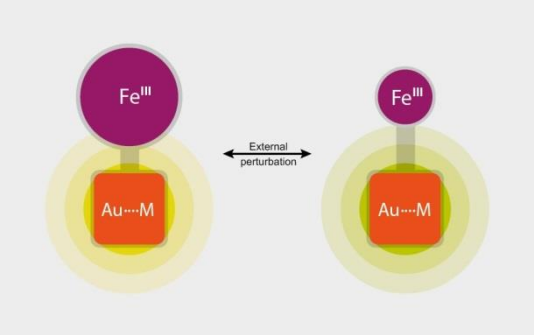
Data storage in binary systems operates by switching between two stable states under ambient conditions and information is written by application of a stimulus. Fabrication of typical data storage devices is made using a top-down approach where the size of magnetic domains has been constantly decreasing.[1] Reduction of size of magnetic domains is only possible until the super paramagnetic limit is reached, producing highly unstable devices.[2,3] To overcome the instability conferred by the superparamagnetic limit, scientists have been developing strategies using diverse and imaginative solutions. However, a new model of spin-based electronics, based on the orientation of individual electron spins to store binary information, offers the tantalizing possibility of non-volatility, increased data processing speed, decreased electric power consumption and increased integration densities.

Magnetic compounds with good potential for incorporation into spintronic materials include spin crossover transition metal compounds.[4] Research has been developed where bistable magnetic states in molecules are addressed mainly by application of temperature or light.

Engineering of multifunctional materials by combining both SCO and luminescence yields hybrid molecules and opens opportunities to develop a range of materials with applications in molecular electronics, nanomedicine and sensors technology.

This research proposal wishes to exploit the fact that is possible to combine more than one function in the same molecule forming hybrid molecular systems. This will be achieved by coordination of luminescent centres based on coinage metals to SCO molecules with functional acetylide groups. The research project here proposed consists of five major parts. The first part of the project is dedicated to the synthesis of both amphiphilic and unfunctionalised SCO Fe(III) molecules.



Acknowledgements

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[1] Dietzel, A., Hard Disk Drives in Nanoelectronics and Information Technology Wiley-VCH: Berlin, 2005.
[2] Charap, S. H., Pu-Ling, L., Yanjun, H., IEEE Trans. Magn., 1997, 33, 978-983.
[3] Martín, J. I., Nogués, J., Liu, K., Vicent, J. L., Schuller, I. K., J. Magn. Magn. Mater., 2003, 256, 449-501.
[4] Kahn, O., Martinez, C. J., Science, 1998, 279, 44-48.

Characterization and identification of essential oils by GC-MS

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Essential oils are fragrant essences of plants, usually volatile oils obtained by steam distillation or other modified methods from different parts of aromatic plants for example buds, flowers, leaves, roots and wood. In general, these oils are complex mixtures of organic compounds constituted by terpene hydrocarbons, oxygenated terpenes and sesquiterpenes. Essential oils have innumerous applications such as perfumery, cosmetics, aromatherapy, medicine and food. The use of these oils has grown due to its properties, especially anticancer, antiviral, antibacterial and antioxidant [1].

Gas chromatography coupled to mass spectrometry (GC-MS) is an important analytical technique, since it combines the power of chromatography separation with the capacity of mass spectrometric identification. GC-MS is a conventional and useful method for analyzing complex mixtures as essentials oils.

In this work, we characterized and identified by GC-MS the components of three essential oils: *Cananga*, *Ylang Ylang III* and *Cinnamon Zeylanicum*. The equipment used was a Trace GC Ultra coupled to an ITQ 900 mass spectrometer with an automatic injector Triplus Rsh from Thermo Scientific. The results were acquired and processed by Xcalibur (version 1.2 from Thermo Scientific). All of the most important peaks were identified by comparison with literature data [2-4] and databases like Wiley 6 and NIST.

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References

[1] G. Buchbauer, in: K.H.C. Bas, G. Buchbauer (Eds.), Handbook of essentials oils: science, technology and applications, CRC Press/Taylor & Francis Group, Boca Raton, 2010, pp 235-280.
[2] M. Brokl, M.L. Fauconnier, C. Benini, G. Lognay, P. du Jardin, J.F. Focant, , Molecules 18 (2013), 1783-1797.
[3] R. Wang, R. Wang, B. Yang, , Innovative Food Sci. Emerging Technol. 10 (2009), 289–292.
[4] E.M. Gaydou, R. Randriamiharisoa, J.P. Bianchinil, J. Agric. Food Chem. 34 (1988), 481-487.

$[FeCl_2(HCpz_3)]$ heterogenized at hierarchical FAU for eco-friendly alkane oxidations

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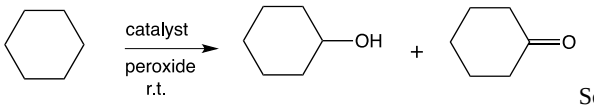
The purpose of this work is i) the preparation of hierarchical materials based on FAU zeolite to work as supports for the immobilization of a C-scorpionate iron(II) complex, the $[FeCl_2(HCpz_3)]$ (pz = pyrazolyl) [1], and ii) their use as heterogeneous catalysts for the oxidation alkanes, namely of cyclohexane to cyclohexanol and cyclohexanone under environmentally friendly conditions (Scheme 1).



Scheme 1

Hierarchical FAU supports were prepared according to the procedure from [2] using NaOH or TPAOH in the presence of hexadecyltrimethylammonium bromide under autogenous pressure. Table 1 shows the main properties of the supports.

Table 1. Crystallinity (C_{XRD}) from X-ray patterns and textural parameters calculated from N_2 adsorption isotherms: microporous (V_{micro}) and mesoporous (V_{meso}) volumes.

Sample	C_{XRD}(%)	V_{micro}[a]($cm^3\ g^{-1}$)	V_{meso}[b]($cm^3\ g^{-1}$)
FAU	100	0.29	0.08
FAU/NaOH	94	0.26	0.15
FAU/TPAOH	92	0.23	0.18

[a]Estimated from α_s method; [b]$V_{meso}=V_{total}-V_{micro}$, where V_{total} is volume adsorbed at $p/p^o=0.95$

The heterogeneous catalysts were prepared using two immobilization procedures: the wet impregnation and the incipient wetness impregnation.
The catalytic tests have shown that these heterogeneous systems exhibit a similar catalytic activity to that found for the C-scorpionate complex in homogeneous media [1] with the advantage of easy separation and re-use.

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[1] T.F.S. Silva, E.C.B.A. Alegria, L.M.D.R.S. Martins, A.J.L. Pombeiro, Adv., Synth. Cat., 350 (2008) 706-716.
[2] J. Garcia-Martinez, M. Johnson, J. Valla, K. Li, J.Y. Ying, Catal. Sci.Technol., 2 (2012) 987-994.

Functional protein-based nanoparticles for reduction of cardiovascular diseases risk

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Cardiovascular diseases are among the highest causes of death in EU [1], being the high cholesterol level in the blood one of the risk factors. The treatment often consists in the administration of drugs that are reported as presenting side effects. Previous work showed that plant infusions and decoctions containing flavonoids and other polyphenols can reduce the serum cholesterol levels [2, 3]. However, some of the compounds tested demonstrated low permeability (e.g. rutin) and also low stability and solubility in water [4]. Encapsulating these flavonoids in proteins can improve this, increasing the uptake by the cells which is expected to have an effect on cholesterol reduction.

As a vital macronutrient in food, proteins possess unique functional properties including the ability to form emulsions which allow them to be an ideal material for the encapsulation of bioactive compounds [5], therefore proteins are suited for the development of delivery systems for bioactive compounds in the form of nanoparticles (NPs). Furthermore, these are considered safe and have nutritional value, and hence the biological products obtained will be applied as functional foods.

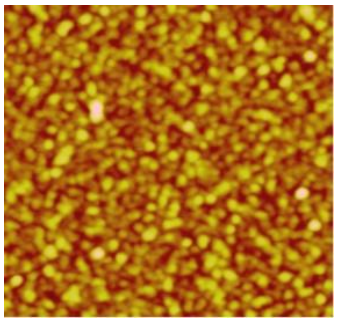

Figure 1: BSA-based nanoparticles containing rutin. Image size: 1µm x1µm, z= 25 nm

The synthesis of the protein-based NPs was made using bovine serum albumin (BSA) loaded with rutin (Rut), as standard, and *Annona cherimola* leaves decoctions, Fig 1. Nanoparticles were prepared in a molar proportion of 10:1 of flavonoid (Rut) to BSA and mixed on a vortex [4]. For NPs loaded with *Annona cherimola* leaves decoctions, the extract stock concentration was adjusted in order for the prepared NPs to have the same Rut concentration as standards [3]. Obtained NPs were characterized through Atomic Force Microscopy (AFM), their permeability study was conducted using an epithelial cell line (Caco-2), normally used to stimulate the intestinal barrier, grown in Transwell plates. Cytotoxicity was determined with MTT viability test, using the same cell line.

In the characterization of each different nanopreparations, AFM has shown small nanoparticles of BSA with loaded Rut (from 20 nm up to 40 nm) and larger aggregates which corresponds to their association. The preparation with the greater dispersion of aggregates was found to be BSA/Annona, possibly due to the variety of the compounds present in *Annona cherimola decoctions.* Future work is expected to increase the uniformity of the nanopreparations. The results have demonstrated that the NPs are not toxic. Our work has accomplished a great improvement in the cells uptake of rutin when encapsulated in BSA in the intestinal barrier, this is expected to contribute in the increase of the benefits of decoctions in cholesterol reduction as well as in the supply of protein for the development of new food supplies

Acknowledgements
FCT for the programmatic financing reference number: UID/MULTI/00612/2013**.**

References

[1] ESC/EAS Guidelines for the management of dyslipidaemias, European Heart Journal, 32, 1769, 2011.
[2] P. L. Falé, C. Ferreira, ,A. M. Rodrigues, F. N. Frazão, M. L. M. Serralheiro. Journal of Medicinal Plants Research, 8, 917, 2014.
[3] P. L. Falé , C. Ferreira , F. Maruzzella, M. H. Florêncio , F.N. Frazão, M.L. M. Serralheiro. Ethnopharmacol, 25, 718-723, 2013.
[4] R. Fang, R. Hao, X. Wu, Q. Li, X. Leng, H. Jing. J. Agric. Food Chem, 59, 6292-6298, 2011.
[5] L. Chen, G. E. Remondetto, M. Subirade. Trends in Food Science and Technology, 17, 272-283, 2006.

CO_2 electroreduction by binuclear Ni(II) and Cu(II) complexes

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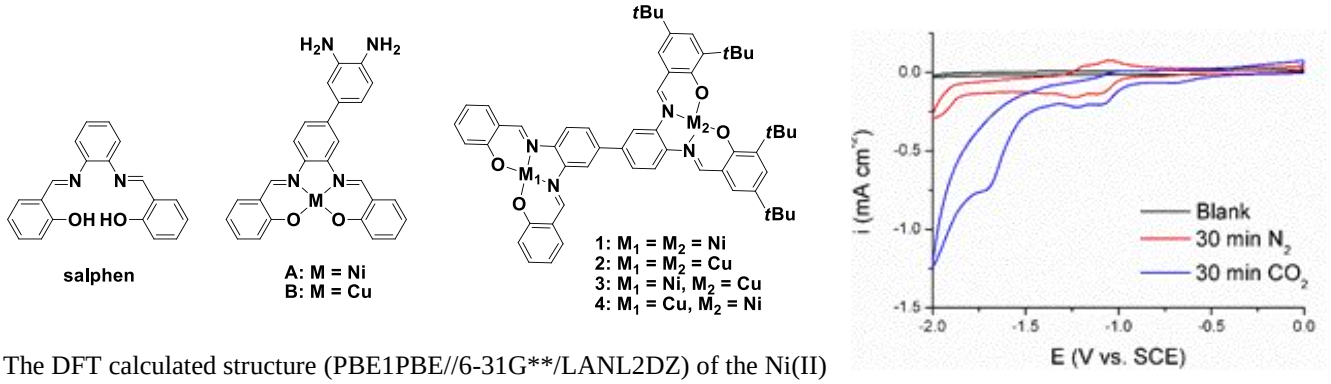
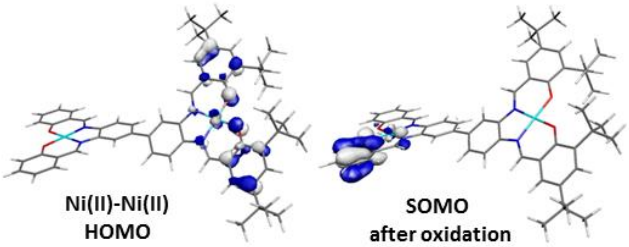
The increasing concentration of CO_2 in Earth's atmosphere and the resulting greenhouse effect have led to a wide effort toward the development of more efficient ways either to its capture, or more interestingly to its utilization in the syntheses of added value chemicals. Despite some reports dealing with the reaction of pressurised CO_2 with epoxides to form polycarbonates [1] or cyclic carbonates [2] and CO_2 conversion by Fe, Ni, Zn and Co based catalysts,[3] many challenges still remain.

Mononuclear (**A**,**B**) and binuclear (**1**, **2**, **3**, **4**) salphen derivatives were synthesized and characterized, and shown to electroreduce CO_2. As depicted in the figure for complex **1**, cyclic voltammetry in the presence of CO_2 leads to an increase in current and the appearance of a reduction peak.



The DFT calculated structure (PBE1PBE//6-31G**/LANL2DZ) of the Ni(II) binuclear complex displays a 40° angle between the planes of the two ligands. The HOMO is π* M-salphen antibonding orbital. However, after oxidation the Singly Occupied MO is localized on two carbon atoms, explaining why these molecules easily polymerize upon oxidation.



The synthesis, electronic structure and reactivity of these complexes will be addressed and a model of the reaction reduction of CO_2 analyzed.

Acknowledgements
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[1] G. W. Coates, D. R. Moore, Angew. Chem. Int. Ed. 43 (2004) 6618.
[2] J. Meléndez, M. North, R. Pasquale, Eur. J. Inor. Chem. 21 (2007) 3323.
[3] J. Qiao, Y. Liu, F. Hong, J. Zhang, Chem. Soc. Rev., 43 (2014) 631.
[4] S. Realista, A. S. Viana, B. P. Cardoso, A. M. Botelho do Rego, P. D. Vaz, A. I. Melato, P. N. Martinho, M. J. Calhorda, RSC Adv. 5 (2015) 39495.

Heterodinuclear Ni(II) and Cu(II) Schiff-base complexes and their oxygen reduction materials

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The versatility of salen-type (salen = *N,N* – bis(salicylidene)ethylenediamine) complexes has been shown, among others, in their extensive applications in electrochemistry owing to their electrochromic,[1] sensor[2] and catalytic[3] properties. These features are complemented by their easy electropolymerisation without significant modifications of the metal environment.[4] Additionally, transition metal complexes with Salen-type ligands have shown to have high catalytic activity and exhibit great performance in the oxygen reduction reaction. Within our interest in engineering materials with synergic properties arising from different catalytic centres, we applied our stepwise synthetic strategy to develop two asymmetric heterodinuclear Ni(II) and Cu(II) monomers. The new monomers (Ni-Cu **1**, Cu-Ni **2**) were used to obtain new electropolymeric films (**Poly1, Poly2**) and evaluate their performance towards oxygen reduction reaction (ORR). They were compared with the homodinuclear analogous complexes (Ni-Ni **3**, Cu-Cu **4**) and electropolymers (**Poly3, Poly4**).

The heterodimetallic complexes of Ni(II) and Cu(II) were prepared via our *in situ* template method.[5] Their characterization was made by FTIR spectroscopy, elemental analyses and HR-mass spectrometry. Modified electrodes were prepared by electrochemical polymerisation of the monomers (heterodinuclear complexes) on both Pt and glassy carbon electrodes in tetrabutylammonium hexafluorophosphate ($TBAPF_6$). The redox behaviour of these polymers was characterised by cyclic voltammetry and the study of the morphologic properties performed by atomic force microscopy (AFM). In order to assess the electrocatalytic activity for the ORR, heterogeneous catalytic studies were made in phosphate solutions (pH=7).

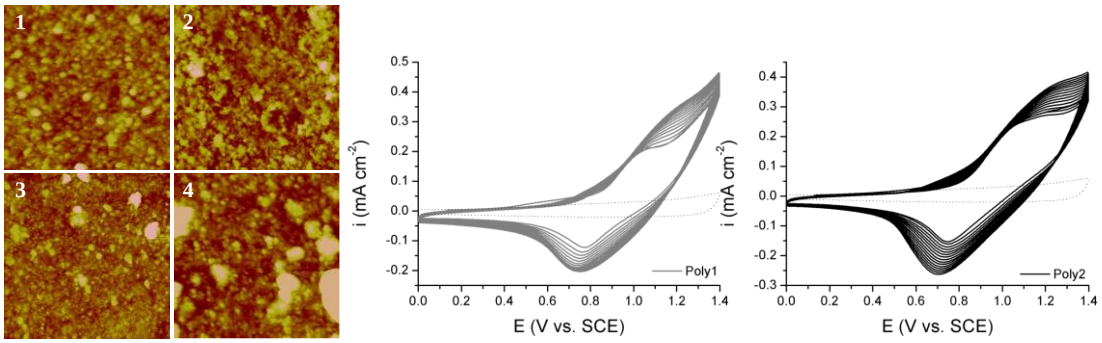

Figure 1. AFM images (2 µm x 2 µm with Z = 60 nm) of Poly1 (1), Poly2 (2), Poly3 (3) and Poly4 (4) films formed under potentiodynamic mode at 200 mV s^{-1}(left) and cyclic voltammograms of the potentiodynamic growth of Poly1 (grey) and Poly2 (black) film on GCE from 1 mM dichloromethane solutions of the monomers. 0.1 M NBu_4PF_6 was used as supporting electrolyte (dotted line). 15 cycles, sweep rate = 200 mV s^{-1}

Acknowledgements

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[1] A. Branco, C. Pinheiro, J. Fonseca, J. Tedim, A. Carneiro, A. Jorge Parola, C. Freire and F. Pina, *Electrochem. Solid St.*, 2010, **13**, J114–J118.
[2] M. R. Ganjali, M. Rezapour, M. R. Pourjavid and M. Salavati-Niasari, *Anal. Sci.*, 2003, **19**, 1127–1131.
[3] J. Du, F. Cheng, S. Wang, T. Zhang and J. Chen, *Sci. Rep.*, 2014, **4**, 4386.
[4] O. F. Filho, E. R. Dockal, L. Humberto, M. Junior and M. F. S. Teixeira, *Anal. Lett.*, 2007, **40**, 1825–1852.
[5] S. Realista, A. S. Viana, B. de P. Cardoso, A. M. do Rego, P. D. Vaz, A. I. Melato, P. N. Martinho and M. J. Calhorda, *RSC Adv.*, 2015, **5**, 39495–39504.

Energy-free reduction of silver from dilute solutions by electroless precipitation (re-)using polyaniline films

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It is well known that the fully oxidized state of polyaniline (pernigraniline form) reduces to produce the protonated emeraldine in acid medium at open circuit potential. It is so expected that in the presence of metallic ions that can act as oxidizing species, spontaneous deprotonation occur with simultaneous reduction of the metal ion - eventually to zero oxidation state (figure 1) – continuing the process while the polymer is exposed to the solution [1]. The high electrochemical potentials of noble metals make them suitable for this electroless precipitation process in polyaniline (PAni) films [2]. This spontaneous, selective (to noble metals) and sustained reduction of metal ions is of particular importance in the field of extractive metallurgy [3].

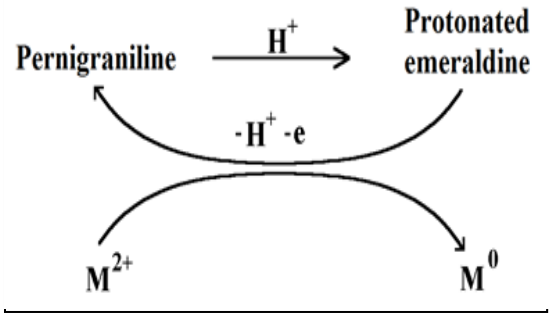

Figure 1. Electroless precipitation mechanism

In this work the process of electroless precipitation of silver from acidic dilute solutions of silver ions is investigated. Thin PAnifilms were electrochemically synthesized on vitreous carbon and stainless steel electrodes and exposed to 1 mM silver solutions for different periods at ambient temperature. The amount of reduced metal in each experiment was assessed by atomic absorption spectroscopy. The effect of film thickness and immersion time in the silver extraction efficiency was evaluated by optical microscopy and electrochemical characterization of the pristine films and after exposure to the silver containing solutions. It was observed that the amount of reduced silver increases with polymer thickening and the metal presence doesn't affect the electroactivity of the polyaniline film. The selectivity of the electroless precipitation methodology to reduce noble metal ions was also evaluated by adding significant amounts of engineering metal ions to the silver solutions. The results clearly demonstrate the effectiveness of the methodology employed in this work to selectively reduce the noble metal ions in solution. The re-use of the polymer films for multiple extraction runs was explored as well.

Acknowledgements
This work is funded by FCT (Fundação para a Ciência e a Tecnologia) through the project UID/MULTI/00612/2013

[1] LM Abrantes and JP Correia, Mat. Sci. Forum, 1995, 191, 235-240
[2] V Lyutov and V Tsakova, J. Solid State Electrochem., 2011, 15, 2553-2561
[3] YP Ting, KH Neoh, ET Kang and KL Tan, J. Chem. Tech. Biotechnol., 1994, 59, 31-36

Luminescent hydrophobic surfaces for smart windows

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The general properties of a material and its wettability may have a huge impact on its usage and application in everyday life. Recently hydrophobic surfaces have attracted research teams to put efforts into combining wettability/hydrophobicity with other interesting properties.

For that purpose, we synthesized three new Zn(II) Schiff-base binuclear complexes displaying both hydrophobic and luminescent properties and studied their deposition on glass surfaces by the low-cost drop-casting method.
The surfaces were prepared by dissolving the new Zn(II) Schiff-base complexes in three different solvents (chloroform, toluene and tetrahydrofuran) using different evaporation rates. Several parameters were taken into account: concentration of the Zn(II) complexes, solvent, temperature, number of layers and surface wettability. The techniques used to characterise both complexes and surfaces were ^{1}H and COSY NMR spectroscopy, FTIR spectroscopy, UV-vis spectroscopy, elemental analysis and contact angle microscopy. We have found that the best solvent to combine hydrophobicity, luminescence and transparency with our Zn(II) Schiff-base compounds was toluene.

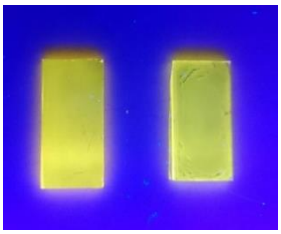

Figure 1. Zn(II) Schiff-base hydrophobic luminescent surfaces.

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References
1 Q. Wei, C. Schlaich, S. Prévost, A. Schulz, C. Böttcher, M. Gradzielski, Z. Qi, R. Haag and C. a. Schalley, *Adv. Mater.*, **26** (2014) 7358–7364.
2 S. Subhash Latthe, *J. Surf. Eng. Mater. Adv. Technol.*, **02** (2012) 76–94.
3 L. Y. Liu Y, Zhao X, Cai B, Pei T, Tong Y, Tang Q, *Pub.Med.*, (2014).

Synthesis and photocatalytic activity evaluation of new titanate nanotubes modified by co-doping with cobalt and rhenium

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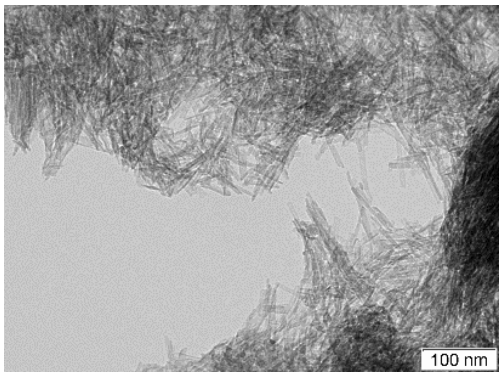
Nowadays, pharmaceuticals and personal care products (PPCPs), are a source of water contamination, and they create several environmental pollution problems. PPCPs include pharmaceutical drugs, cosmetics, food supplements and other personal care products. Unfortunately, after use, these products are disposed in the environment, usually without any treatment. Photocatalysis technology offers an efficient and environmental friendly approach for the elimination of different kinds of pollutants [1]. In particular, the use of nanocrystalline semiconductors on the photocatalytic treatment of wastewaters has been generating great interest.

Titanate nanotubes (TNTs) are very interesting since they combine the properties and applications of conventional TiO_2 nanoparticles, with the properties of layered titanates, such as photocatalytic activity and ion-exchange ability, respectively. In addition, the intrinsic properties of these 1D materials, mainly surface area, physical and chemical adsorption ability, optical and photocatalytic properties, can be tailored and adjusted to a specific application/interaction. However their high charge recombination rate and wide band gap limit their practical application. Therefore, the synthesis of TNT-based materials with either a broader range of light absorption or a lower charge recombination rate would be an important achievement toward the development of successful photoactive catalytic materials. For instance, the modification of TNTs with a transition metal (e.g. Co and/or Re), could reduce the charge recombination, and extend their optical absorption and photocatalytic performance of the pristine material.

In this work, nanocrystalline TNTs materials modified by cobalt and/or rhenium doping (CoTNT, ReTNT and CoReTNT) were successful prepared, by hydrothermal method [2], and characterized using XRD, XPS, TEM and DRS. The influence of the Co and Re content on the optical and photocatalytic activity of the samples was investigated using the terephthalic acid as the probe molecule to study the catalytic production of hydroxyl radical (•OH). The photocatalytic performance was subsequently studied using PPCPs (caffeine and paracetamol) as model pollutants. The best catalytic sample was then tested on a mixture of the two pollutants. The results show that the Co and/or Re modified TNTs samples (CoTNT, ReTNT and CoReTNT) are better catalysts than the unmodified TNTs.



TEM image of doped TNTs.

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The authors thank FCT for financial support (UID/MULTI/00612/2013 and SFRH/BD/101220/2014).

[1] D. Zhang, R.M. Gersberg, W.J.Ng, S.K. Tan, Environmental Pollution 184 (2014) 620-639.
[2] E.K. Ylhäinen, M.R. Nunes, A.J. Silvestre, O.C. Monteiro, J. Mater. Sci.47 (2012) 4305–4312.

Synthesis of new CNS-targeted drug-like leads against Alzheimer's disease: the role of the sugar moiety in *C*-glucosyl flavonoid analogues

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Alzheimer's disease (AD) is the most common form of dementia, which currently affects over 46 million people worldwide.[1] Yet, despite continuous efforts over the past 30 years, no cure is possible with the drugs delivered to the market so far.

Natural polyphenols such as quercetin, apigenin and chrysin have been reported for their striking neuroprotective effects, including the ability to decrease amyloid-β (Aβ)-induced neurotoxicity while reducing β-secretase-mediated amyloid precursor protein (APP) processing, improving cognitive function and memory retention in rodents.[2-4] Due to the multifactorial nature of AD, we envisage that the broad activity of polyphenols comes across as a desirable feature of new multitarget drug leads, that ought to tackle several pathological features, thus maximizing the chances of blocking neurodegenerative progression.

Preliminary assays conducted by our group have shown that flavones tend to be more effective in inhibiting the formation of $A\beta_{1-42}$ amyloid fibrils than the analogue flavanones or isoflavones. Quercetin, in particular, showed an astonishing anti-amyloidogenic effect, which prompted us to synthesize flavone analogues with drug-like properties and to inspect the role of *C*-*C* linked glucose units, that stabilize amyloid polypeptides in their disaggregated state.[5] Ultimately, it is our goal to unveil structural requirements for the anti-amyloidogenic and neuroprotective effects, and to find new blood brain barrier (BBB)-permeable molecules that combine key features of the flavone scaffold with the benefits of the sugar moiety.

In this communication, the synthesis of *C*-glycosylated and non-glycosylated flavone analogues will be presented and their therapeutic potential against AD discussed. Moreover, given the tight association between type 2 diabetes and AD, the usefulness of this type of compounds in type 2 diabetic patients with cognitive impairment will also be debated.

Acknowledgements
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[1] Prince M., Wimo A., Guerchet M., Ali G.C., Wu Y.T., Prina M. World Alzheimer's Report **2015**.
[2] Sabogal-Guáqueta A.M., Muñoz-Manco J.I., Ramírez-Pineda J.R., Lamprea-Rodeiguez M., Osorio E., Cardona-Gómez G.P. *Neuropharmacology*, **2015**, 93, 134.
[3] Zhao L. Wang J.L. Liu R., Li X.X., Li J.F., Zhang L. *Molecules*, **2013**, 18(8), 9949.
[4] Li. R. Zang A., Zhang L., Zhang H., Zhao L., Qi Z. Wang H. *Neurol Sci*, **2014**, 35, 1527.
[5] Ladiwala A.R.A, Mora-Pale, Lin C., Bale S.S., Fishman Z.S., Dordick J.S., Tessier P.M. *ChemBioChem*, **2011**, 12(11), 1749.

Reverse selectivity of zeolites and MOFs in the ethane/ethylene separation by adsorption

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Ethylene is a key building block for plastics and has a major importance in petrochemical industry. The separation of ethylene from ethane is made by distillation which implies that more than 75% of the ethylene costs are due to the high energy consumption that is needed to separate it from ethane [1]. Advances in the ethane/ethylene separation will be related with the discovery of adsorbents that present preferential adsorption of ethane over ethylene. Metal-organic frameworks (MOFs) are crystalline materials consisting of metal ions, or ion clusters, and organic ligands. Gas chromatography is most informative for materials screening for the ethane/ethylene separation since it needs only few mg of sample, and gives selectivity results at various temperatures [2]. This type of screening is essential in the first step of the assessment during the development of the materials, before adsorption measurements at high pressures and possible scale up of the synthesis.

This is illustrated by the methodology presented in this work where materials from two types of families (zeolites and MOFs) were used to show the reversed selectivity that can be found towards the ethane/ethylene separation. Figure shows the selectivity values obtained at various temperatures.

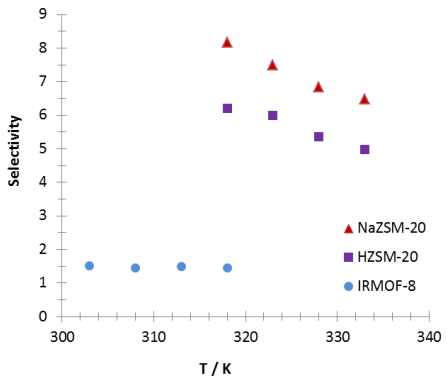

Figure 1. . Selectivity values for the ethane/ethylene separation in the studied materials

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[1] D.M. Ruthven, Ind. Eng. Chem. Res. 2000, 39, 2127−2131.
[2] J. Pires,M. L. Pinto, V. K. Saini, ACS Applied Materials & Interfaces 2014, 6, (15), 12093-12099.

Opi1p translocation to the nucleus is regulated through oxidation by hydrogen peroxide in *Saccharomyces cerevisiae*

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Adaptation of yeast cells to hydrogen peroxide (H_2O_2) leads to a rapid change in membrane permeability accompanied by a decrease of membrane fluidity and the alteration of its lipid composition, allowing cells to survive to higher doses of H_2O_2 (1,2). During adaptation to H_2O_2 several genes that contain the regulatory element UAS_{INO}, and which codify for enzymes involved in phospholipid and fatty acid metabolism, are repressed (2,3). This repression is due to the translocation into the nucleus of the endoplasmic reticulum-bound transcriptional repressor Opi1p (4). However, the mechanisms of regulation of this translocation regulated by H_2O_2 are still unknown.

Oxidation of particular cysteine residues in proteins by H_2O_2 is involved in signaling cascades that culminate in the regulation of transcription (5). Opi1p has in its structure four cysteine residues that may be targets of oxidation. Such oxidation might be responsible for the H_2O_2-dependent translocation of Opi1p to the nucleus and subsequent transcriptional repression of target genes. Opi1p oxidation when cells were exposed to adaptive doses of H_2O_2 was confirmed by a protein electrophoresis (SDS-PAGE), after tagging oxidized protein cysteine sulphydryl groups with methoxy-polyethylene glycolmaleimide (MAL-PEG) (6). To determine whether Opi1p cysteine residues are responsible for H_2O_2-mediated translocation of Opi1p to the nucleus, yeast strains with individual mutations in cysteine residues were prepared (cysteine to alanine substitutions). These mutations did not compromise the function of Opi1p as a transcriptional repressor, since all cells presented similar levels of expression of a reporter gene containing UAS_{INO}. As expected, the wild-type strain displayed Opi1p mainly in the endoplasmic reticulum, which translocated to the nucleus in the presence of H_2O_2. In clear contrast, Opi1p translocation to the nucleus in cells treated with H_2O_2 was impaired in the C159A mutant, with Opi1p being equally distributed in the periphery and inside the nucleus. These results identify cysteine residue 159 of Opi1p as responsible for H_2O_2-mediated translocation of this protein to the nucleus.

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(1) Branco, M. R., Marinho, H. S., Cyrne, L., and Antunes, F. (2004) *J. Biol. Chem.* **279,** 6501-6506;
(2) Pedroso, N., Matias, A. C., Cyrne, L., Antunes, F., Borges, C., Malhó, R., de Almeida, R. F., Herrero, E., and Marinho, H. S. (2009) *Free Radic. Biol. Med.* **46,** 289-298;
(3) Cepeda, A. (2010) Estudo da regulação da expressão do sintase de ácidos gordos de *Saccharomyces cerevisiae* na aquisição de resistência ao peróxido de hidrogénio. MSc. thesis, FCUL;
(4) Loewen, C. J., Gaspar, M. L., Jesch, S. A., Delon, C., Ktistakis, N. T., Henry, S. A., and Levine, T. P. (2004) *Science* **304,** 1644-1647;
(5) Marinho, H.S., Real, C., Cyrne, L., Soares, H., Antunes, F. (2014) Redox Biol. **2**, 535-562.
(6) Wu H-H,Thomas J.A.. and Momand J.,(2000) Biochem. J. **351**, 87-93

Novel BiOCl-Bi_2S_3 nanostructures synthesized from deep eutectic solvents and its photocatalytic properties

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The development of new materials displaying improved chemical and physical properties have been subject of intense research for application in (photo)catalysis, supercapacitors and energy storage devices [1-4]. The possibility of preparing hybrid materials allows to combine the individual properties of its constituents in materials with improved performance which can be tuned, by design, through adequate combination [5,6].

In this work, a novel route for the preparation of bismuth oxychloride (BiOCl) nanoparticles sensitised with Bi_2S_3 in a one-step method, at room temperature from an environmentally friend deep eutectic solvent, is reported. The influence of the synthesis conditions, temperature, sulphur source, concentration of reactants and presence of water, on the structural, morphological, optical and photocatalytic properties of the synthesized nanoparticles is analysed and discussed.

Under the experimental conditions used here, it was found that the sulphur source and the Bi:S ratio in the synthesis solution play important roles in the preparation and properties of such materials. The photocatalytic activity was tested towards the rhodamine B degradation under UV-vis light irradiation with the hybrid materials showing promising results.

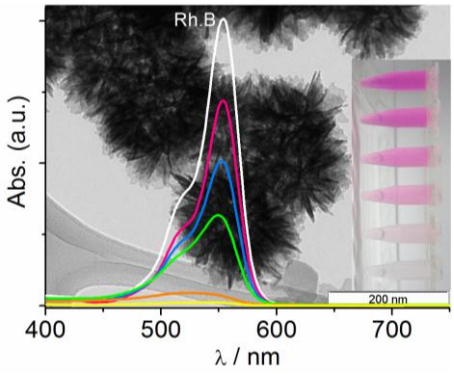

Figure 1. BiOCl-Bi_2S_3 TEM image and its photocatalytic performance for RhB degradation under UV-vis light irradiation.

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[1] G. Li, B. Jiang, S. Xiao, Z. Lian, D. Zhang, J. C. Yu, H. Li, Environ. Sci.: Processes Impacts 16 (2014) 1975-1980.
[2] Z. Jiang, Y. Liu, T. Jing, B. Huang, Z. Wang, X. Zhang, X. Qin, Y. Dai, RSC Adv. 5 (2015) 47261-47264.
[3] J. Yuan, J. Wang, Y. She, J. Hu, P. Tao, F. Lv, Z. Lu, Y. Gu, J. Power Sources 263 (2014) 37-45.
[4] Y. Zhang, S. Lu, M.-Q. Wang, Y. Niu, S. Liu, Y. Li, X. Wu, S.-J. Bao, M. Xu, Mater. Lett. 178 (2016) 44-47.
[5] C. Cao, L. Xiao, C. Chen, Q. Cao, Appl. Surf. Sci. 357 (2015) 1171–1179.
[6] Y. Yang, F. Zhou, S. Zhan, Y. Liu, Y. Yin, J. Inorg. Organomet. Polym. 26 (2016) 91–99.

Development of a LC-MS/MS method for quantitative analysis of nine pharmaceutical compounds in surface water samples

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Emerging contaminant, are by definition chemical compounds that are not monitored because they have unknown toxicological effects or have no regulatory legislation. Emerging compounds may be of synthetic or natural origin, found in products consumed by a large population and end up in natural ecosystems [1]. Pharmaceutical drugs are included in this group. Many of these drugs can cause aquatic toxicity, genotoxicity and endocrine interference on biota and humans. These compounds are found in superficial waters, underground waters and sewage effluents[2,3].

This study aimed to develop a method for the analysis, in an environmental matrix, of antidepressant drugs as amitriptyline (AMI), bupropion (BUP), venlafaxine (VEN), citalopram (CIT), trazadone (TRA) and duloxetine (DUL). Anticancer drugs as methotrexate (MET), ifosfamide (IF), cyclophosphamide (CYP) were also studied.

LC-ESI-MS/MS (electrospray ionization-tandem mass spectrometry) in MRM (Multiple Reaction Mode) was performed for the detection and quantification of those drugs. Sample preparation used a nylon membrane (0.45 μm) for filtration and added 0.1% formic acid to acidify the sample to pH 3 or 0.1M sodium hydroxide to pH 7 for comparison of the influence of pH on the extraction. Solid phase extraction was performed on a cartridge of hydrophilic-lipophilic balance, Oasis HLB (200mg, 6 mL, Waters) previously conditioned with 5 ml methanol and 5 ml water, washed with 5 ml 5% methanol in water and eluted with 5 ml methanol. The eluate was evaporated to dryness under a gentle stream of nitrogen and the dried extracts were stored at −5 °C until analysis.

The method showed good selectivity (Table 1), with detection limits between 0.6 and 1.2 ng L^{-1} and quantification limits were between 2 and 4 ng L^{-1}. Superficial waters were collected and examined for the presence of possible contaminants. Recoveries were calculated by spiking the samples before extraction at a concentration of 40 ng L^{-1} and for matrix effects, standards with blank water extracts spiked, were compared, after extraction. The results of the recoveries were better at pH 3 in the range of 72-110% and matrix effects for pH 3 were in the range of 59-103%. The method is adequate to detect and quantify these pharmaceutical drugs in environmental matrices. For future studies it is intended to collect samples of effluent treatment plants to determine the presence and confirm the removal of these compounds.

Table 1 - Conditions for the quantification of pharmaceuticals compounds.

Drugs	*L.D (ng L^{-1})*	*L.Q (ng L^{-1})*	*Linearity (ng L^{-1})*	*r^2*	*Rt*	*m/z (quantification)*	*m/z (confirmation)*	*Re pH 3 (%)*	*Re pH 7 (%)*	*ME pH 3 (%)*
CIT	1.2	4	4-400	0.9974	5.93	325>108.8	325>262	101.76	92.68	89.47
VEN	0.6	2	2-400	0.9954	5.44	278.1>57.7	278.1>260	105.02	51.38	62.55
AMI	1.2	4	4-400	0.9980	6.21	278.1>90.8	278.1>233	72.86	28.57	58.85
BUP	1.2	4	4-400	0.9962	5.32	240>184	240>166	118.58	108.0	81.49
TRA	0.6	2	2-400	0.9976	5.7	372>176.1	372>147.9	97.49	79.05	103.33
DUL	1.2	4	4-400	0.9952	6.21	298>153.9	298>43.7	109.86	59.58	96.01
MET	1.2	4	4-400	0.9930	5.56	454.9>308	454.9>175	96.21	107.8	78.32
CYP	0.6	2	2-400	0.9952	7.17	261>139.9	261>119.8	101.05	106.1	75.88
IF	1.2	4	4-400	0.9927	7.08	260.9>153.9	260.9>91.8	110.98	108.5	89.51

L.D = Limit of detection; L.Q = Limit of quantification; r^2 = Correlation coefficient; Rt = Retention time; R e= Recovery; ME = Matrix Effect.

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[1] Stuart, M et al., The Science of the Total Environment 416 (2012), p.1–21.
[2] Giebultowicz, J et al., Ecotoxicology and Environmental Safety 104 (2014), p.103–109.
[3] Golovko, O et al., Chemosphere 111 (2014), p.418–426.

AChE inhibition and antioxidant activity of *Centaurium erythrae* (Fel da terra) infusions

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Centuarium erythrae is a plant (Fig.1 left) with laxative effect, used to treat lack of appetite and hyperglycemia. Acetylcholinesterase (AChE) is an enzyme localized in the neurosynapic junctions[1] and its inhibition can increase intestinal motility[2]. Aqueous extracts of leaves from *C. erythrae* showed an inhibitory activity towards AChE of 0.8 mg/mL (IC_{50}). The presence of gentiopicroside and secoiridoid glycoside was detected by LC-MS/MS (Fig. 1 right). The aqueous extract was fractioned by HPLC-DAD in order to separate the compounds present in the mixture: gentiopicroside (corresponding to the peak of the graph) and the compounds before and after this peak, corresponding to the first and third fraction, respectively. Docking studies revealed gentiopicroside as a mild AChE inhibitor. Indeed, the experimental results demonstrated that 300 μg/mL of gentiopicroside inhibited the enzyme in 23%, while the same amount of the third fraction, containing flavonoid derivatives, showed 40% of AChE inhibition, highlighting the relevant role of these compounds, and the first fraction inhibited in 29%. Further studies are ongoing to identify the remaining flavonoids present in these fractions. The aqueous extract showed an IC_{50} of 1.7 mg/mL towards HepG2 and MCF7 cell lines. This modest value indicates that no toxicity was detected with the infusion. On the other hand, 0.5 mg/mL of gentiopicroside had a percentage of cytotoxicity of 15%, while the first and third fractions showed values of 11% and 37%, respectively, to the same concentration towards MCF7 cell line. The extracts, even after digestion with gastrointestinal enzymes, retained their AChE inhibitory activity and no modifications in the chromatogram were observed. The extracts when subject to the gastrointestinal enzymes did not loose the AChE inhibitory activity and when analysing the chromatogram no modifications were noticed. Once again third fraction had the best values regarding the antioxidant activity (EC_{50} = 0.134 mg/mL), the first fraction had an EC_{50} of 0.495 mg/mL and 0.05 mg/mL of gentiopicroside showed an antioxidant activity of 13%.

In conclusion gentiopicroside has a moderate AChE inhibitory activity as well as a low antioxidant activity.

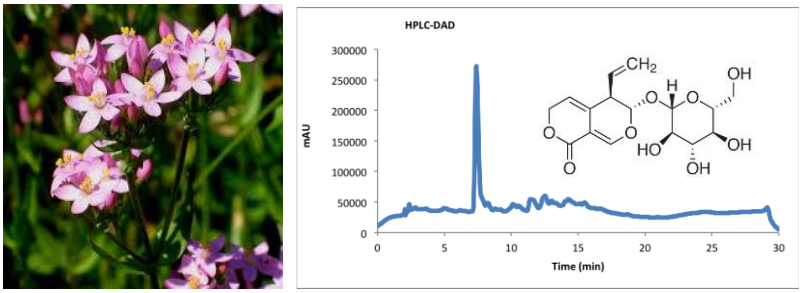

Figure 1. Picture of *C. erythrae* plant (left) and HPLC chromatogram of the extract (right) showing gentiopicroside identified as the main peak.

Acknowledgements

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[1] Devlin TM. Muscle contraction. In: Devlin, T.M. Eds. Textbook of Biochemistry with Clinical Correlations. Wiley-Liss, New York, 1997, pp. 954.

[2] S. Cellek, R. Thangiah, E.M. Jarvie, S Vivekanandan, O. Laludew, G.J. Sanger, Neurogastroenterol Motil. 20 (2008) 539–545.

Novel titanate nanotubular materials modified with transition metals for the photocatalytic degradation of PPCPs

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In the later years, the consumption of pharmaceuticals and personal care products (PPCPs) such as, antibiotics, stimulants, endocrine disruptors, food supplements and others, has increased. In result, the release of these compounds into the environment have been rapidly increasing and, with them of some phenomena such as, the appearance of antibiotic resistant bacteria or the increase of some endocrine diseases has also increased [1]. Several PPCPs removal methodologies have already been proposed but the definitive answer to solve this issue is far from being found.

The use of nanocrystalline semiconductors as photocatalysts, on the treatment of industrial wastewaters, has generated great interest, due to their unique physicochemical properties. TiO_2 has been the most extensively used semiconductor in the removal of a large number of organic pollutants from water systems. However, TiO_2 has a major drawback in processes associated with solar photocatalysis due to its wide bandgap (3.2 eV), making it difficult to implement an overall technological process based on TiO_2 [2]. The high recombination rate of photo-charge carriers is also a handicap for this semiconductor large scale application. Therefore, the synthesis of TiO_2-based materials, *e.g.* titanate nanotubes (TNT), with a broader range of light absorption and a lower charge recombination rate would be an important achievement towards the development of successful photoactive materials [2].

This work reports on the synthesis of nanocrystalline TNT-based materials modified by both transition metal and ion-exchange (TNT/M) and doping (M-TNT), prepared via a hydrothermal treatment of an amorphous undoped and M-doped precursors recently reported. The transition metals selected for this study were Mn, Cu, Ni and Cr. The influence of the transition metal position in the TNT structure on the optical and photocatalytic properties of the materials was studied. The photocatalytic activity of the samples was firstly investigated using the terephthalic acid (TA) as probe molecule to study the catalytic production of hydroxyl radical (•OH). Their photocatalytic performance was subsequently studied using caffeine and sulfamethazine as model pollutants. The results show that either M-TNT or TNT/M modified samples are better catalysts than the pristine TNT, being the photocatalytic performance dependent on the transition metal used and on its position in the TNT crystalline structure.

Acknowledgements
The authors thank FCT for financial support (UID/MULTI/00612/2013)

[1] B. Kasprzyk-Hordern, R. Dinsdale, A. Guwy, Water Research 43 (2009) 363-380.
[2] E. K. Ylhäinen, M. R. Nunes, A. J. Silvestre e O. C. Monteiro, Jounal of Materials Science 47 (2012) 4305-4312

A new semi-empirical equation to describe the surface tension of aqueous organic liquid mixtures

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A thermodynamic analysis demonstrates that the dependence of the surface tension on composition is linearly related to the reciprocal of each component standard molar surface area, with no simple mixing formula linking the ideal surface tension to pure-component surface tensions.

The ability of five empirical equations [1-5] frequently used to correlate the surface tension of ideal and real binary aqueous organic mixtures is examined (Figure 1). Polynomial equations are not able to describe the overall trend of surface tension variation across the entire composition range and equations containing a hyperbolic term perform much better.

A new hyperbolic equation containing two theoretically estimated parameters, C_1 and C_2, is proposed

$$\pi_{\mathrm{red}} = \frac{x_{\mathrm{B}}}{1 + C_0 (1 - x_{\mathrm{B}})} \left[1 + \sum_{k=1}^{n} C_k (1 - x_{\mathrm{B}})^k \right]$$

and its performance compared with the previous proposals, resorting to published data for water–ethanol [6,7], water–propan-2-ol [8], water–ethanenitrile [8] and water–1,4-dioxane [9] at T = 298 K.

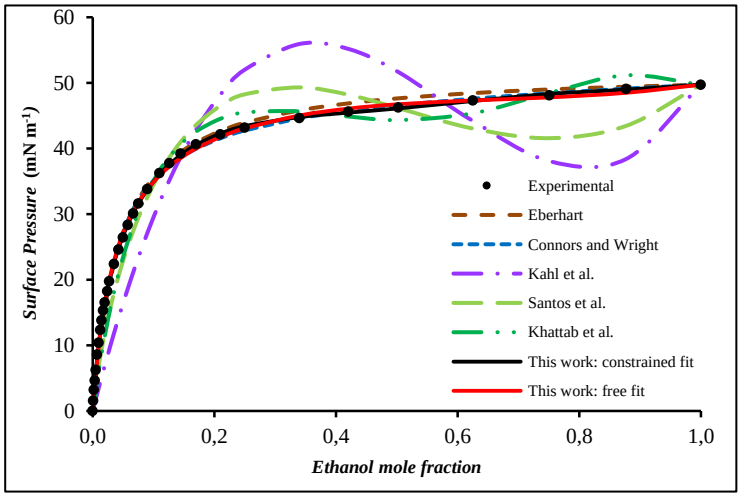

Figure 1. Fitting ability of various equations for the surface pressure, $\pi = \gamma_{\mathrm{A}}^{*} - \gamma$, dependence on composition for water (A)–ethanol (B) mixtures at T = 298.15 K .

Acknowledgements

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[1] J.G. Eberhart, J. Phys. Chem. 70 (1966) 1183–1186.
[2] K.A. Connors, J.L. Wright, Anal. Chem. 61 (1989) 194–198.
[3] H. Kahl, T. Wadewitz, J. Winkelmann, J. Chem. Eng. Data 48 (2003) 1500–1507.
[4] B.M.S. Santos, A.G.M. Ferreira, I.M.A. Fonseca, Fluid Phase Equilib. 208 (2003) 1–21.
[5] I.S. Khattab, F. Bandarkar, M.A.A. Fakhree, A. Jouyban, Korean J. Chem. Eng. 29 (2012) 812–817.
[6] M. Aratono, T. Toyomasu, M. Villeneuve, Y. Uchizono, T. Takiue, K. Motomura, N. Ikeda, J. Colloid Interface Sci. 191 (1997) 146–153.
[7] R. Strey, Y. Viisanen, M. Aratono, J.P. Kratohvil, Q. Yin, S.E. Friberg, J. Phys. Chem. B 103 (1999) 9112–9116.
[8] A.A. Rafati, A. Bagheri, M. Najafi, J. Chem. Eng. Data 55 (2010) 4039–4043.
[9] S. Nath, J. Colloid Interface Sci. 209 (1999) 116–122.

Exploiting 2-deoxy glycosides towards new antimicrobial and neuroprotective compounds

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The increasing average life expectancy in developed countries has led to an escalating concern associated with the emergence of age-related diseases, such as dementia, a condition that is characterized by the loss of memory and other intellectual abilities interfering with daily life. Alzheimer's disease (AD) is the most common type of dementia noteworthy for its devastating nature and unsuccessful treatment options. The main characteristics of AD patients' brains include the extracellular deposition of amyloid-β peptides in senile plaques, the deposition of neurofibrillary tangles, the loss of synaptic function, inflammation and neuronal death.[1]

Alkyl 2-deoxy/2,6-dideoxy-*arabino*-hexopyranosides with a potent antimicrobial activity in some Gram positive bacteria have been previously described by our research group,[2] and their mechanism of action was recently unravelled (unpublished results). Preliminary results have also shown that some of these glycosides interact with cystatin B amyloid fibrils, inspiring us to investigate 2-deoxy glycosides embodying natural neuroprotective polyphenols as aglycones. Rosmarinic acid was previously identified by our research group as the active principle of the neuroprotective plant *Salvia sclareoides*, as it prevents amyloid aggregation, and reduces a number of other events underlying AD pathology.[3] Much attention has been paid also to resveratrol, due to its ability to inhibit Aβ oligomeric cytotoxicity and reduce neuronal cell death.[4] Envisioning bioavailability enhancement of these products and taking into account the physico-chemical properties of carbohydrates/amyloid interaction, methodologies towards a series of rosmarinic acid and resveratrol glycosylated analogues were developed and will be presented. Their key structural features for neuroprotective properties will be proposed according to Aβ fibrillization assay results monitored by ThT fluorescence.

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[1] D.J. Selkoe. Physiol. Rev. 81(2) (2001) 741.
[2] A. Martins, M.S. Santos, C. Dias, P. Serra, V. Cachatra, J.Pais, A.P. Rauter et al. Eur. J. Org. Chem. (2013) 1448.
[3] a) F. Marcelo, C. Dias, A. Martins, P.J. Madeira, T. Jorge, M- H. Florencio, J. F. Canada, E. Cabrita, J. Jimenez-Barbero, A. P. Rauter. Chem. Eur. J. 19(21) (2013) 6641. b) C. Airoldi, E. Sironi, C. Dias, F. Marcelo, A. Martins, A.P. Rauter, F. Nicotra, J. Jimenez-Barbero. Chem. Asian J. 8 (2013) 596. c) T. Alkam,A. Nitta, H. Mizoguchi, A. Itoh, T. Nabeshima. Behav. Brain Res. 180(2) (2007) 139.
[4] S.D. Rege, T. Geetha, G.D. Griffin, T.L. Broderick, J.R. Babu. Front. Aging Neurosci. 6 (2014) 1.

Acetylcholinesterase inhibition, antioxidant activity, *in vitro* gastrointestinal digestion and toxicity of Cladodes from *Opuntia Ficus Indica* extracts on HepG2, Mcf-7 and Caco-2 cell lines

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Opuntia ficus indica cladodes (nopal), it is a member of *Cactaceae* family. Several studies have reported that nopal exerts beneficial effects on health[1]. In fact, cladodes are used for treating arteriosclerosis, diabetes, gastritis and hypercholesterolemia[2]

The aim of this study was to identify the chemical composition of the extracts of *Opuntia ficus indica* and determine the inhibition of acetylcholinesterase, the antioxidant activity, and to evaluate if the chemical composition and activities remained after *in vitro* gastrointestinal digestion. This activity can be attributed to the presence of piscidic acid, eucomic acid and isorhamnetin glycosides. Several purification procedures were used to obtain a bioactive mixture with which different studies were carried out.

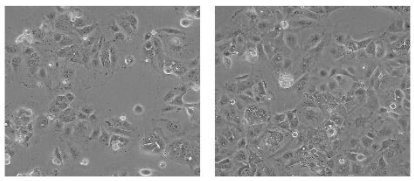

Figure 1: Caco-2 cells used for toxicity tests

The toxicity of the extracts was also tested with Caco-2, HepG2 and MCF-7 cells. The antioxidant activity measured as half maximal effective concentration (EC_{50}) values ranged from 0.89 to 1.30 mg/mL and the acetylcholinesterase inhibition activity of the three extracts determined as half inhibitory concentration (IC_{50}) was between 2.8 and 0.03 mg/mL. The composition and the biochemical activities remained after the *in vitro* gastrointestinal digestion. The infusions showed no toxicity against the 3 types of cell lines.

Acknowledgements

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[1] E.M. Galati, et al. Pharm. Biol. 41 (2003) 175–179.

[2] A. Trejo-González, et al. J. Ethnopharmacol. 55 (1996) 27–33.

Are pH-sensitive amino acids in their most common protonation states at the water/membrane interface?

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The study of biological membranes has been for quite some time a challenge for researchers. A detailed description of the water/membrane interface has to take in consideration all important factors and pH is recognizably one of them, even though it is usually ignored due to its high complexity in terms of modelling. The pK_a values of typical titrable amino acids can be significantly influenced by changes in the environment, i.e., peptide insertion into a lipid bilayer [1-2].

The main objective of this work is a comprehensive study of how a membrane environment can shift the pK_a values of common pH-sensitive amino acids (Asp, Glu, His, Lys, Cys, Tyr, and the N- and C-termini). For this, we used our recently developed CpHMD-L methodology [3] with a DMPC membrane and the model Ala-based pentapeptides that have already been well characterized in water by Pace and co-workers [4]. With this approach, we intend to capture the coupling between conformation/configuration/ insertion and protonation at the membrane interface, taking into consideration that if complete insertion occurs, the peptides will probably no longer be able to exchange protons with the solvent (Figure 1).

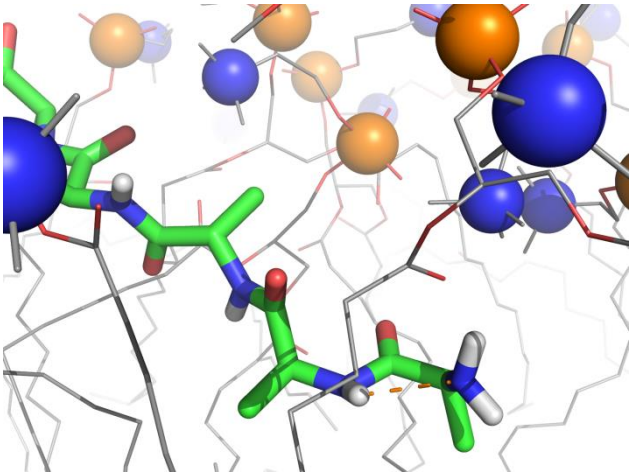

Figure 1. The Ala_5 pentapeptide at the water/ membrane interface.

Acknowledgements
We acknowledge financial support from FCT projects UID/MULTI/00612/2013 and PTDC/QEQCOM/5904/2014.

[1] J. F. Hunt, P. Rath, K. J. Rothschild, D. M. Engelman, Biochemistry 36 (1997) 15177.
[2] P. R. Magalhães, M. Machuqueiro, A. M. Baptista, Biophys. J. 108 (2015) 2282.
[3] D. Vila-Viçosa, V. H. Teixeira, A. M. Baptista, M. Machuqueiro, J. Chem. Theory Comput. 11 (2015) 2367.
[4] R. L. Thurlkill, G. R. Grimsley, J. M. Scholtz, C. N. Pace, Protein Sci. 15 (2006) 1214.

Mn(III) single ion magnet with a tridentate Schiff-base ligand

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Single ion magnets (SIMs) are a class of materials with potential application as high-density magnetic memories and quantum-computing devices in spintronic field.[1] The size of the barrier of the reversal magnetization (U_{eff}) is the determining factor to the suitability of a single ion magnet to be applied in data storage devices. Efforts aiming at maximizing the anisotropy by an appropriate ligand field have been made to achieve high barriers.[2] Manganese(III) is a d^4 metal ion displaying a Jahn-Teller (JT) distortion when in an octahedral coordination environment. This feature turns Mn(III) into an promising ion to study its magnetic properties, namely spin crossover[3] and single ion magnet[2]. We report the synthesis of Mn(III) Schiff base cationic complexes (Figure 1) using different counter anions. SQUID magnetometry showed that all compounds are in the high-spin state with one pair of bond lengths (Mn-Namine) considerably longer than the others (Figure 1). Both magnetic and HF-EPR measurements reveal that the complex has the largest axial zero field splitting (D = -4.6 cm^{-1}) known to date for a Mn(III) single ion magnet. AC magnetic measurements at 2000 Oe allowed to determine the energy barrier for spin reversal (10.19 K) and spin reversal relaxation time ($1.476x10^{-6}$ s) for the Mn(III) ion. Computational studies were used to characterise the electronic structure and substantiate the zero field splitting in the Mn(III) complex.

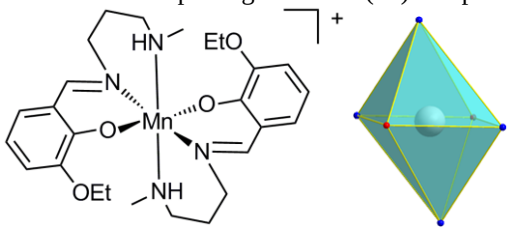

Figure 1. Cation structure

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[1] J. Vallejo, A. Pascual-Álvarez, J. Cano, I. Castro, M. Julve, F. Lloret, J. Krzystek, G. De Munno, D. Armentano, W. Wernsdorfer, R. Ruiz-García, E. Pardo, Angew. Chemie Int. Ed., 2013, 52, 14075.
[2] G. A. Craig, M. Murrie, Chem. Soc. Rev., 2015, 44, 2135.
[3] P. N. Martinho, B. Gildea, M. M. Harris, T. Lemma, A. D. Naik, H. Müller-Bunz, T. E. Keyes, Y. Garcia and G. G. Morgan, Angew. Chemie - Int. Ed., 2012, 51, 12597.

Polymorphism or thermal disorder in 4-hydroxyheptanophenone?

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Studies of polymorphism involving families of structurally related molecules are particularly interesting to understand how the interplay of molecular size, shape and interactions may affect the packing architectures and relative stability of different crystal forms. One such families consists of 4-hydroxybenzoyl compounds, HOC6H4C(O)R (R = H, alkyl), differing only in the length of the alkyl chain bonded to the carbonyl group. Based on these compounds it is, for example, possible to investigate how the hydrogen bond pattern sustaining the packing is affected by changes in the alkyl chain length.

Results of single crystal X-ray diffraction (SCXRD) analysis on 4-hydroxyheptanophenone will be reported. These results evidenced that on increasing temperature in the range 150-298 K, the crystal system is unaltered and the observed structural changes are essentially related with modifications in the conformational freedom of the alkyl chain (Figure 1). These changes are likely to be responsible for heating rate sensitive thermal events detected by differential scanning calorimetry. The 4-hydroxyheptanophenone packings corresponding to the low and high ends of the temperature range probed for will be compared with those also obtained for other $HOC_6H_4C(O)R$ compounds that were also studied by SCXRD.

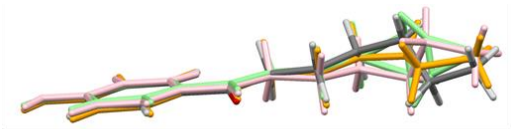

Figure 1. Overlay of molecular structures of 4-hydroxyheptano phenone at 150 K (■), 190K (■), 220K (■), and 290K (■)

Acknowledgements

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Photocatalytic degradation of carbamazepine and ibuprophen in water using novel TiO_2-MoO_2 materials

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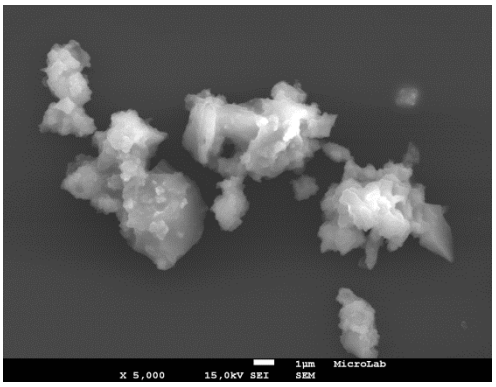
The increase of the amount of pharmaceutical and cosmetic products in lakes, rivers and even drinking water has become a concerning matter for the world's health. Such chemicals are classified as emerging pollutants. [1] Different treatment methods have been reported but heterogeneous photocatalysis gained increased attention, with titanium oxide (TiO_2) being the most known and used photocatalyst in water treatment. Such choice is due to its strong photocatalytic activity, chemical stability, nontoxicity and low cost. However, it presents a critical drawback: the wide band gap of TiO_2 makes only possible the use of the ultraviolet fraction of the solar light (3–5%) [2]. Great efforts have been made for shifting its light absorption towards the visible region and thus improve its photocatalytic efficiency. Similarly, molybdenum oxides are also attractive due to their unique structural and optical properties and they are broadly employed in electrochromic and photochromic devices, gas sensors and lithium batteries.



In this study, new photocatalytic materials were prepared by combination of TiO_2 and MoO_2 particles. Nanocrystalline particles and nanocomposites were prepared using a hydrothermal approach. The new hybrid materials were structural, morphological, and optically characterized by X-ray diffraction (XRD), transmission and scanning electron microscopy (TEM/SEM), diffuse reflectance spectroscopy (DRS) and Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS).

Regarding their future photocatalytic application, the materials were first used to evaluate the catalytic quantum yield of hydroxyl radical (•OH) using terephthalic acid as probe molecule. The main purpose of the new hybrid materials was achieved by testing their photocatalytic performance concerning the degradation of carbamazepine and ibuprophen as water pollutants and preliminary results show their promising application in water treatments.

Acknowledgments

The authors thanks Fundação para a Ciência e Tecnologia for financial support (UID/MULTI/00612/2013).

[1]T. A. Ternes, Water Res., 32(1998), 3245–3260.

[2] M. Kaneko and I. Okura (Eds.), Photocatalysis: Science and Technology, Biological and Medical Physics Series, Springer, Berlin 2010.

Amino acid intercalated clays as green materials for carbon dioxide adsorption

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The global awareness of changes in biosphere has increased considerably in recent years, especially concerning the problematics of climate change. The majority of climate researchers agree that this phenomenon is associated with the high concentration of greenhouse gases in the atmosphere, particularly carbon dioxide [1]. Carbon sequestration, a relatively new concept, has been proposed to reduce atmospheric CO_2, especially from stationary sources. Technology may be relatively complex but the basic idea is to separate the CO_2 from flue gas streams and to trap it in oceans, terrestrial ecosystems, and geological formations including depleted gas, oil, and coal formations. Also, the use of CO_2 as a raw material in chemical processes has been investigated [1,2]. Amine modified materials have been proposed for CO_2 adsorption, since the amounts of CO_2 adsorbed are known to increase due to the specific interaction with amine groups [3].

In the present work, and in the search for low-cost sustainable materials for carbon dioxide adsorption, clay based materials were prepared by the intercalation of a montmorillonite with amino acids such as glycine (Gly), arginine (Arg) and Histidine (His) at two diferent pH values. The obtained carbon dioxide adsorption isotherms are presented in Figure 1.

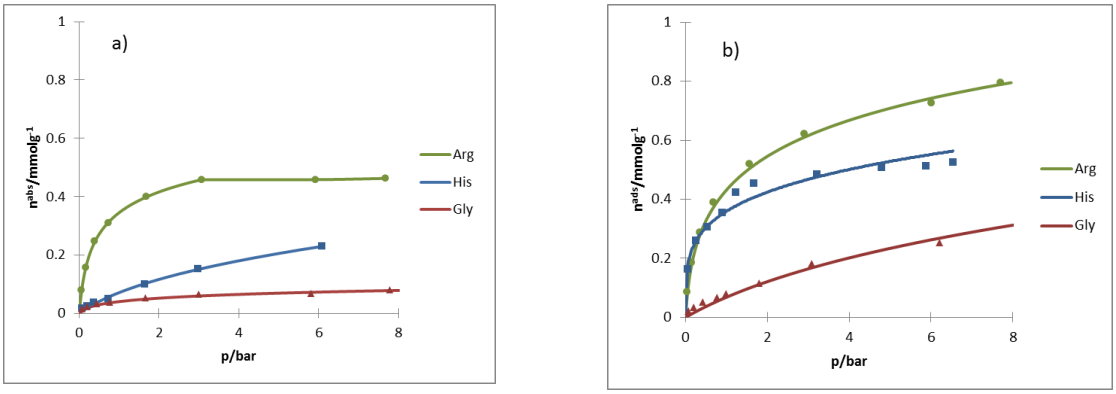

Figure 1 Adsorption isotherms of CO_2 at 25 ºC for montmorillonite intercalated with the indicated amino acids at pH=7 (a) and pH = 5 (b)

Acknowledgements
The authors thank the Foundation for Science and Technology for funding CQB UID/MULTI/00612/2013 and CERENA (UID/ECI/04028/2013).

[1] C. S Song. Catal. Today 115 (20061-4) 2–32.
[2] R. Srivastava, D.Srinivas, P. Ratnasamy, J. Catal. 233 (2005) 1–15.
[3] M.L. Pinto, L. Mafra, J.M. Guil, J. Pires, J. Rocha. Chem. Mater. 23 (2011) 1387-1395.

pH-dependent insertion of pHLIP peptide into lipid bilayers: pK_a values of key residues

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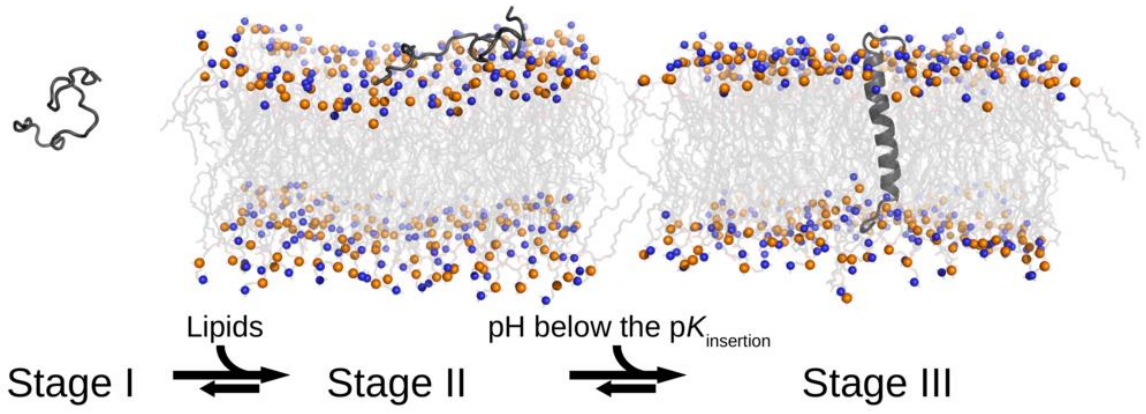
The pH (low) insertion peptide (pHLIP)[1-3] is a family of peptides that are able to insert into a lipid bilayer at acidic pH. These peptides are based in a transmembranar sequence of bacteriorhodopsin that is unstructured in solution (stage I), interacts with lipid bilayers remaining unstructured at neutral pH (stage II) and inserts into the bilayer with a significant α-helical content at acidic pH (stage III). This family of peptides have already been used to target tumor cells in vivo since acidosis is an hallmark of these tissues.[4] These events are difficult to study at the molecular level, in particular, the relation between the pK of insertion of pHLIP peptides and the pK_a of some key residues is yet to be clarified. In this work, we used a linear response approximation to determine the pK_a of these residues. We studied four different pHLIP variants to understand the importance of the ASP positions and its mutation to GLU. For these variants, there are experimental data available that we used to validate our approach. Finally, we also propose a mutation to a HIS residue in the sequence, expecting to turn off the pHLIP peptide insertion into the membrane (stage III) at too low pH values.



We acknowledge the financial support from FCT (PTDC/QEQCOM/5904/2014 and UID/MULTI/00612/2013).

[1] J. F. Hunt, P. Rath, K. J. Rothschild, D. M. Engelman, Biochemistry, 36:15177 (1997)
[2] M. Musial-Siwek, A. Karabadzhak, O. A. Andreev, Y. K. Reshetnyak, D. M. Engelman, BBA, 1798:1041 (2010)
[3] J. Fendos, F. N. Barrera, D. M. Engelman, Biochemistry, 52:4595 (2013)
[4] D. Weerakkody, A. Moshinoka, M. S. Thakur, V. Moshinoka, J. Daniels, D. M. Engelman, O. A. Andreev, Y. R. Reshetnyak, PNAS, 9:5834 (2013).

$[VO_2\{HB(3,5\text{-}Me_2pz)_3\}]$ supported at hierarchical MOR for eco-friendly ciclohexane oxidation

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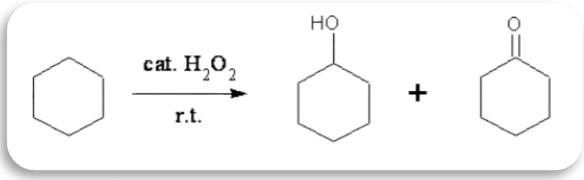
In this work hierarchical MOR zeolite was used as support for the immobilization of B-scorpionate dioxido-V(V) complexes, *e.g.*, $[VO_2\{HB(3,5\text{-}Me_2pz)_3\}]$ [1]. The immobilized complexes were tested as catalysts for the oxidation of cyclohexane, with hydrogen peroxide, to cyclohexanol and cyclohexanone under environmentally friendly conditions (see Scheme below).



Hierarchical MOR supports were prepared according to the procedure from [2] using NaOH or TPAOH in the presence of hexadecyltrimethylammonium bromide under autogenous pressure. Table 1 shows the main properties of the supports.

Table 1. Crystallinity (C_{XRD}) from X-ray patterns and textural parameters calculated from N_2 adsorption isotherms: microporous (V_{micro}) and mesoporous (V_{meso}) volumes.

Sample	C_{XRD}(%)	V_{micro}[a]($cm^3\ g^{-1}$)	V_{meso}[b]($cm^3\ g^{-1}$)
MOR	100	0.19	0.04
MOR/NaOH	90	0.16	0.11
MOR/TPAOH	88	0.14	0.09

[a]Estimated from α_s method; [b]$V_{meso}=V_{total}-V_{micro}$, where V_{total} is volume adsorbed at $p/p^o=0.95$

The heterogeneous catalysts were prepared by the incipient wetness impregnation method. The catalytic tests have shown that the V(V) heterogeneous systems can be used as selective catalysts for the oxidation of cyclohexane to the mixture of cyclohexanol and cyclohexanone, under very mild conditions, allowing their easy separation and recycling.

Acknowledgements

Support for this work was provided by FCT through PEst UID/MULTI/00612/2013, UID/QUI/00100/2013, PTDC/QEQ-ERQ/1648/2014 and PTDC/QEQ-QIN/3967/2014.

[1] T. F. S. Silva, K.V. Luzyanin, M. V. Kirillova, M. F. Guedes da Silva, L. M. D. R. S. Martins, A. J. L. Pombeiro, Adv. Synth. Catal. 352 (2010) 171-187.
[2] J. Garcia-Martinez, M. Johnson, J. Valla, K. Li, J.Y. Ying, Catal. Sci.Technol., 2 (2012) 987-994.

New intermetallic electrocatalysts for hydrogen production

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Clean and sustainable molecular hydrogen (H_2) production can be achieved through electrochemical water splitting [1].
The hydrogen evolution reaction (HER) requires an electrocatalyst which lowers the overpotential and promotes higher exchange current density values. Rare-earth-based AB_2 intermetallic compounds can be seen as potential hydrogen electrocatalysts due to their high activity towards HER [2].

The intermetallics studied were based on the earth abundant, inexpensive Cu element combined with different lanthanides to prepare three distinct compounds – $PrCu_2$, $GdCu_2$ and $YbCu_2$.

These materials were prepared in the form of ingots by induction melting using high-purity metals in the adequate proportion. The melting process was repeated at least three times in order to ensure a perfect homogeneity.
Working electrodes were assembled using a PTFE cavity electrode filled with a mixture of powdered intermetallic compound and conductive carbon paste (CP), in a 1:1 mass ratio, for optimal current collection.

In order to assess the electrocatalytic properties of these intermetallics and their activity for the hydrogen evolution reaction (HER) in alkaline medium at different temperatures, electrochemical techniques like linear voltammetry (LV) and chronoamperommetry (CA) have been applied. The analysis of the polarization curves allow the determination of the kinetic parameters - Tafel slope, transfer coefficient and exchange current density - which are crucial to understand the hydrogen formation mechanism.

From Figure 1, it could be concluded that the intermetallic compounds can be ordered as $PrCu_2 > GdCu_2 > YbCu_2$ due to their ability to the hydrogen reaction since a current of I = -2 mA is reached at -1.34, -1.41 and -1.47 V *vs* Hg/HgO, respectively.

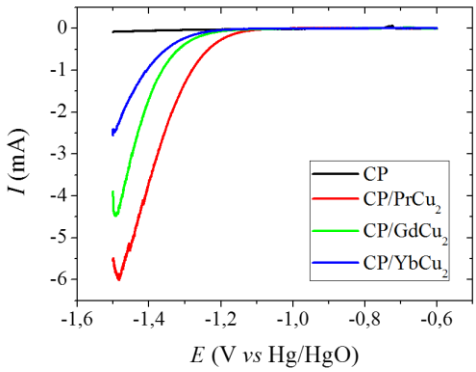

Figure 1. Linear voltammograms recorded for the different electrodes under study at room temperature. Sweep rate of 1 mVs^{-1}.

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References

1. C. G. Morales-Guio, L. A. Stern and X. Hu, *Chem. Soc. Rev.* **(2014)** 43, 6555;
2. M. Tliha, C. Khaldi, S. Boussami, N. Fenineche, O. El-Kedim, H. Mathlouthi and J. Lamloumi, *J. Solid State Chem.* **(2014)** 18 (3), 577.

Bioactivity and phytochemical studies on Tunisian globe rrtichoke (*Cynara scolymus*) wastes

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Globe artichoke (*Cynara scolymus*) is an ancient herbaceous perennial plant original from the Mediterranean Basin, but it is extensively cultivated all over the world. From this vegetable only the inner leaves and hearts are considered edible, whereas externals bracts, leaves, and stems are food industrial by-products. These wastes represent more than 60% of the fresh weight, and they are generally used as animal feedstuff and for fiber production or discarded, with additional waste treatment costs in compliance with environmental laws. Over the last years, artichoke is attracting the scientific, industrial, and public communities by its beneficial effects such as antibacterial, antioxidant, anti-HIV, hepatoprotective, urinative, anti-inflammatory, anticarcinogenic, anti-hypercholesterolemic and cardiovascular protective properties.

Analytical studies on the phytochemical profile of Tunisian artichoke wastes showed that phenolics, like caffeoylquinic acid and flavonoids, are major constituents. However, little attention has been paid to their potential as a source of functional ingredients. Therefore, the present work highlights the biological activities of artichoke extracts, giving special attention to the *in vitro* antioxidant, antibacterial, and anti-inflammatory activities of leaves and floral stem residues of Tunisian globe artichoke cultivar " Violet d'Hyères". Our results indicate that phenolic compounds may be responsible for the strong antioxidant, antimicrobial and anti-inflammatory properties denoted by the studied extracts, fractions, and isolated compounds. So, these wastes can be regarded as a cheap source of new functional ingredients for food and pharmaceutical industries.

Acknowledgements

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The effect of *P. barbatus* and *P. zuluensis* infusions on protein secondary structure investigated using FTIR spectroscopy

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The genus *Plectranthus* L Herit. (Lamiaceae), with ca. 300 species of herbs and shrubs, is widely distributed in Africa, Asia, Australia and some Pacific Islands. Many *Plectranthus* species are cultivated for their edible tubers, as essential oil crops or ornamentals, while others are used in folk medicine for the treatment of many disorders and diseases.[1] This family has several biological activities amongst which antioxidant and enzyme inhibition, such as inhibition of acethylcolinesterase (AchE), can be mentioned. These activities are due to phenolic compounds.[2] The reversible inhibition of AchE enzyme activity has been used in the treatment of Alzheimer symptoms [3] and gastrointestinal (GI) disorders [4], among other diseases.

To study some of these plants' activities, infusions of leaves of *P. barbatus and P. zuluensis* were prepared. The major components of the infusions were identified by LC-MS and rosmarinic acid was identified as the major component although some flavonoids derivatives were also present [5].

In order to analyze the effects of infusions consumption with meals, these infusions were mixed with proteins and their effects were studied and analyzed using Fourier Transform Infrared (FTIR) spectroscopy. Different infusion:protein ratios, such as 1:10, 1:2 and 1:1, were tested using both infusions. The effect of temperature on the interaction was also monitored. Based on preliminary results, both infusions altered the secondary structure of the model protein bovine serum albumin (BSA) as an increase in the absorbance in the region 1630 cm^{-1} was seen, Fig 1. This was noticeable for higher concentration of infusions and more evident after temperature treatment. Further studies will allow us to determine if the obtained data could correlate to variations in the biological activities of the infusions due to the presence of proteins.[6] This study gives insight into the protein binding to mixtures containing phenolic compounds and its impact on antioxidant activity and enzyme inhibition.

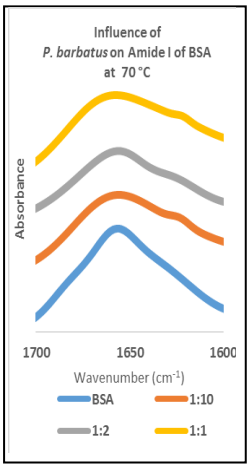

Figure 1: Effect of *Plectranthus barbatus* infusion on BSA secondary structure

Acknowledgements

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[1] L.J. Rice a, G.J. Brits b, C.J. Potgieter c, J. Van Staden, *S. Afr. J. Bot.,* **2011**, *77*, 947–959.
[2] S. S. El-hawary, R. H. El-sofany, A. R. Abdel-Monem, R. S. Ashour, A. A. Sleem**,** *Phcog. J*. **2012**, *4* , 45-54.
[3] Nair VP, Hunter JM. *Crit. Care Pain*. **2004**, 4 164-168.
[4] Zhang L, Song Y, Lu C, *et al*. *Exp Ther Med,* 2013, **5**: 793-796.
[5] P.L.Falé, C.Borges, P.J.Amorim Madeira, L.Ascensão, M.E.M.Araújo, M.H.Florêncio, M.L.M.Serralheiro. *Food Chem*, **2009**, *114*, 798-805.
[6] Raquel Zorilla, Li Liang, Gabriel Remondetto, Muriel Subirade. *Dairy Sci. & Technol*, **2011**, 91:629–644.

Why is INH-C_{10} more active than INH against *Mycobacterium tuberculosis*? Decoding the puzzle...

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Tuberculosis (TB) is still nowadays a serious global threat. Its causative agent, *Mycobacterium tuberculosis* (*Mtb*), has become increasing resistant to the most effective 1st line antitubercular drugs, in particular to isoniazid, INH (Figure 1). New INH-based compounds have been proposed to circumvent *Mtb* resistance and therefore improve drug activity. To become active against *Mtb*, INH needs to be first activated by the catalase-peroxidase KatG enzyme. Among the most promising compounds, INH-C_{10} (Figure 1), a new acylated INH derivative was shown to have a similar activity to INH against the *wt* strain but a MIC value six times lower against a *katG* S315T mutated strain [1]. It was recently observed using MD simulations that this increased activity could not be assigned to changes in the steric environment of the access channel to the heme site, since they were not found to be significant, but rather to subtle electrostatic changes in the vicinity of the heme pocket which will, in the end, influence its reactivity [2].

In an effort to understand the twists of INH and INH-C_{10} in KatGs, crystallographic studies were undertaken. Having seen no evidence of binding in the soaking experiments with INH-C_{10} in the enzyme, NBT assays were also carried out to assess the amount of free radicals produced in the first step of the reaction of INH-C_{10} in KatG. Results showed that this reaction was much slower than that of INH which was not expected from the experimental binding constants and MIC values.

To shed some light into these findings, a computational study was performed where the energetic barriers of radical formation for INH and several acylated INH derivatives (INH-C_x, with x = 2,4, 6, 8, 10) were calculated at the quantum level. In this study, a simple free energy difference between products and substrates in the activation reaction was evaluated. The difference for each acylated compound was compared with INH ($\Delta\Delta G$) and it was noted that it is always positive and nearly constant (around 9-10 kcal mol^{-1}). Therefore, the radical formation in these derivatives is thermodynamically less favoured (deactivated) than in INH and independent on the size of the alkyl chain, assuming that KatG deals similarly with all compounds. These results suggest that, despite its smaller reactivity, the hydrophobic nature of INH-C_{10} may promote a better trafficking through the *Mtb* membrane, leading to higher concentrations in the vicinity of KatG, thus resulting in lower MIC values.

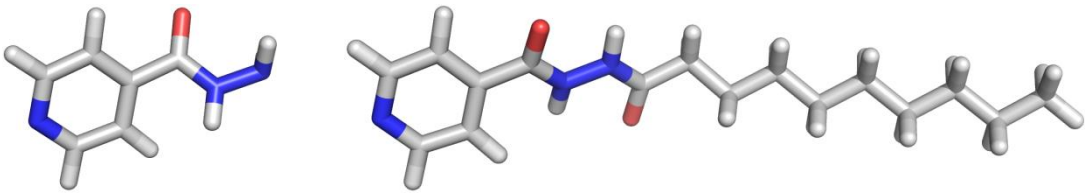

Figure 1. Optimized structures of INH (left) and INH-C_{10} (right).

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The authors are grateful to Fundação para a Ciência e a Tecnologia, Portugal, for financial support under projects PEst-OE/QUI/UI0612/2013 and UID/MULTI/00612/2013.

[1] F. Martins, S. Santos, C.Ventura, R. Elvas-Leitão, L. Santos, S. Vitorino, M. Reis, V. Miranda, H. F. Correia, J. Aires-de-Sousa, V. Kovalishyn, D.A.R.S. Latino, J. Ramos, M. Viveiros, Eur. J. Med. Chem. 81 (2014) 119-138.
[2] V.H. Teixeira, C. Ventura, R. Leitão, C. Rafols, E. Bosch, F. Martins, M. Machuqueiro, Mol. Pharm. 12 (2015) 898−909.

Identification of psychoactive substances in seized products in Portugal

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In the past few years, and in particularly in the last 5 years, there has been an uprising of New Psychoactive Substances (NPS) available in "smartshops" and over the internet, with a rate of two new substances detected every week. NPS are psychoactive substances not internationally controlled but that may pose a risk similar to traditional drugs. In 2015, 100 new substances were detected for the first time, bringing the total number of NPS monitored to 568. Now, there are more than twice new substances on the market as compounds controlled under international conventions. Synthetic cathinones and synthetic cannabinoids are the most abundant classes of NPS reported in EU. Since 2005, 160 synthetic cannabinoids and 103 synthetic cathinones have been monitored [1].

Three years ago, a new law has been implemented in Portugal (Dec-Lei 54/2013 de 17 de Abril)[2], which forbids the production and commercialisation of about 159 NPS, being liable to fast updates, in order to keep up with the everyday appearance of new substances.

This project is being developed within the scope of the collaboration between the *Faculdade de Ciências da Universidade de Lisboa* (FCUL) and the *Laboratório de Polícia Científica da Polícia Judiciária* (LPC/PJ), as a result of the need to create effective analytical databases that will facilitate the quick identification of these drugs in a forensic context in Portugal.

This study describes the identification and characterisation of five psychoactive substances (**Figure 1**) detected in seized products in Portugal: three synthetic cannabinoids (STS-135, 5F-AKB-48, 5F-PB-22); one synthetic cathinone (MPHP) and a tryptamine (4-OH-MiPT). Additionally, raw materials such as 8-quinolinol and adamantylamine used in the synthesis of some of those substances were also detected.

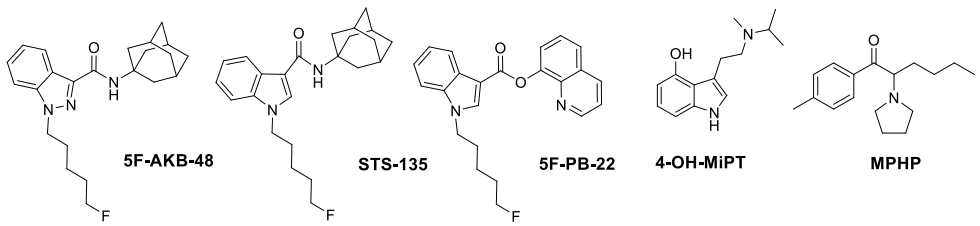

Figure 1. Structure of the five psychoactive substances identified in seized product in Portugal.

Using the complementary information from different analytical techniques (1D/2D NMR, GC-EI-MS and ESI-MS), it was possible to determine unequivocally the structures of the psychoactive substances present in the samples without using chemical standards or any kind of purifications. However, in order to use those compounds as qualitative standards for further identifications of NPS, the 3 cannabimimetic substances identified were also isolated and purified from the seized samples.

Acknowledgments
The authors thank FCT for financial support through project UID/MULTI/00612/2013.

[1] European Monitoring Centre for Drugs and Drug Addiction, *European Drug Report 2016 - Trends and Developments*, Publications Office of the European Union, Lisbon, 2016.
[2] Decreto-Lei 54/2013, *Diário da República*, 1.ª série, No. 75, 17 de abril de 2013.

Conducting polymers exhibiting pseudo cationic doping for cathodes in Li-ion batteries

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The unique properties of conducting polymers have been explored for a variety of applications and these materials have been well succeeded in many fields [1,2]. Poly(3,4 ethylenedioxythiophene) doped with poly(styrene-4-sulfonate) (PEDOT:PSS) exhibits characteristics like, among others, the porosity and the pseudo-cationic doping, making it an attractive choice for electrodes in Li-ion batteries [3,4]. Besides the stability, the character and easiness of mass transfer, in particular that of the Li+, during the charge/discharge processes of the polymer, is a crucial parameter for the performance of such devices [5].

In this work the mass transfer phenomena taking place during the redox conversion of PEDOT:PSS films is investigated by coupling electrochemical methods with microgravimetry (EQCM), Probe Beam Deflection (PBD) and in-situ ellipsometry in two different organic solvents containing LiClO4. Polymeric films were potentiostatically and potentiodynamically synthesized onto platinum electrodes from aqueous solutions containing the monomer and PSS. The combined information of the PBD and EQCM allows distinguishing the solvent mass fluxes from that of the ions that can be resolved individually. The ellipsometric information acquired both in the course of the synthesis and during the redox conversion process was mathematically treated and fitted to a suitable physical model in order to monitor the film thickness and dielectric constants change imparted by the mass fluxes in the polymer matrix. The data revealed a quite fast quasi-ideal pseudo-cationic doping being the perchlorate anion participation in the conversion process almost negligible. Long runs of charging/discharging conversions of the PEDOT:PSS demonstrated the high stability of electric and mass transfer responses of the modified electrodes.

Acknowledgements

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[1] PM Dziewoński, M Grzeszczuk, Electrochim. Acta, 55 (2010) 3336.
[2] N Oyama, T Sarukawa, Y Mochizuki, T Shimomura, S Yamaguchi, J. Power Sources, 189 (2009) 230.
[3] AL-Oleksiak, K Kazubowska, A Kupniewska, J. Electroanal. Chem., 501 (2001) 54.
[4] D Han, G Yang, J Song, L Niu, AIvaska, J. Electroanal. Chem., 602, (2007) 24.
[5] AL-Oleksiak, A Kupniewska, Solid State Ionics, 157 (2003) 241.

Mo NP's as selective catalyst in the oxidation of benzyl alcohol

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Heterogeneous catalysis has recently extended to synthetic organic chemistry for production of fine chemicals and pharmaceuticals. Heterogeneous catalysts are convenient to use on a large scale, present a high surface area of the catalytically active phase and also have many other advantages such as easy separation and recycling process compared to homogeneous counterparts. Metal-oxide nanoparticles atracted a lot of interest for their emerging enhanced properties as good catalysts since they act as heterogeneous but applications are still scarce. Oxidation of alcohols to aldehydes and ketones is one of the most important transformations in organic synthesis.[1] In particular the oxidation of primary alcohols to aldehydes is important since they find wide applications as intermediates in fine chemicals particularly for perfume industry [2,3] and in food chemistry. Oxidation of alcohols is carried out using stoichiometric inorganic oxidants and reactions have to be performed under severe conditions, such as high temperature and high oxygen pressure. An important reaction is the synthesis of benzaldehyde from benzyl alcohol; this transformation is challenging since it often generates not only the aldehyde, but also toluene or even benzoic acid (resulting from the over-oxidation of the aldehyde).[4] Over the recent years we have designed Mo-based heterogeneous catalysts that under mild conditions (temperatures in the 328–373 K range with *tert*-butylhydroperoxide as oxidant) yield selectively the desired products.

With this in mind, in this work MoO_2 nanoparticles with tremella-like morphology have been synthesized and characterized. The MoO_2 nanoparticles were prepared by a hydrothermal method using ethylenediamine as reducing and hydroquinone or iron oxide (Fe_2O_3) as assisting agents, respectively [2,3]. The solvothermal synthesis method is a new procedure starting from MoO_3 mixed with ethylenediamine and hydroquinone.

Its catalytic activity as heterogenous catalyst was explored in the oxidation of benzyl alcohol to its aldehyde.

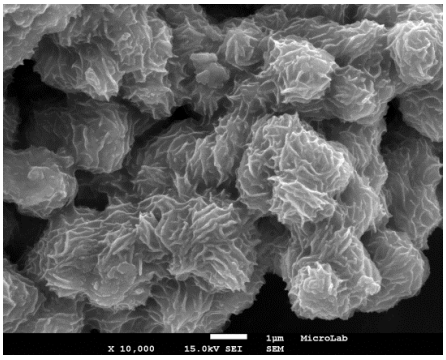

Figure 1. SEM image of MoO_2 nanoparticles evidencing their tremella-like morphology

The resulting materials were tested as catalytic precursors in the oxidation of benzyl alcohol into its aldehyde. Reactions were carried out using *tert*-butylhydroperoxide (tbhp) or hidrogen peroxide (H_2O_2) as oxygen sources. The catalytic studies show that the synthesized materials yield selectively the desired oxidation product with interesting and very good results including the preferential formation of benzaldehyde over benzoic acid in benzyl alcohol oxidation with MoO_2.

Despite this the material prepared with Fe_2O_3 shows some formation of benzoic acid. When this material works under stoichiometric oxidant/substrate conditions it still shows high efficiency. In addition, this material has a wider scope for oxidants, since it is capable of catalyzing oxidation reactions in the presence of H_2O_2.

Acknowledgements
The authors thank FCT for financial support (UID/MULTI/00612/2013).

[1] R. A. Sheldon and J. K. Kochi, Metal-Catalysed Oxidations of Organic Compounds, Academic Press, New York, 1981.
[2] Enache, D. I.; Edwards, J. K.; Landon, P.; Solsona-Espriu, B.; Carley, A. F.; Herzing, A. A.; Watanabe, M.; Kiely, C. J.; Knight, D. W.; Hutchings, G. J. Science 2006, 311, 362-365.
[3] Hudlicky, M. Oxidations in Organic Chemistry; American Chemical Society: Washington, DC, 1990.
[4] E. Nowicka, J. P. Hofmann, S. F. Parker, M. Sankar, G. M. Lari, S. A. Kondrat, D. W. Knight, D. Bethell, B. M. Weckhuysen and G. J. Hutchings, Phys. Chem. Chem. Phys., 2013, 15, 12147–12155.

Catalytic esterification uing hydrothermally synthesized carbon spheres

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Carbon spheres have drawing the attention of the scientific community due to their high electrical conductivity and excellent chemical stability, that can also be allied to a developed porosity. As a consequence, the potentialities of these materials as supercapacitors, catalyst supports and adsorbents have being explored.

One possible strategy to synthetize these type of materials is through hydrothermal treatments. The most commonly used carbon precursors to prepare hydrochars are renewable biomasses, e.g,. glucose, xylose, maltose, sucrose, amylopectin or starch.[1]

The carbon spheres tested in this study were obtained by a one-step procedure using sucrose or glucose aqueous solutions in the presence of acrilic acid. The solids have acidic surfaces due to the presence of carboxylic acids and alcohols, as demonstrated by the Bohems titration results, and pHpzc values of ca. 2.0. These surface characteristics allowed us to consider their use as catalysts for esterification reactions which in industry (e.g. production of biodiesel and food industry) are usually catalysed by strong acids as H2SO4.[2] The results obtained so far point out the potentialities of these materials as alternatives to strong inorganic acids, being a step forward to turn esterification a more green process.

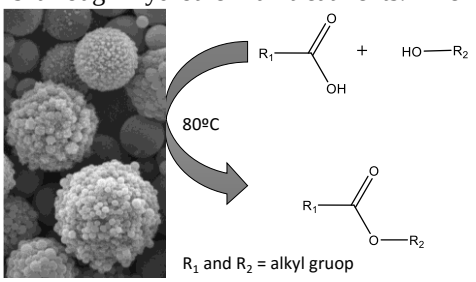

Figure 2. Esterification catalysed by synthetic carbon spheres.

Acknowledgements
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References
[1] R. Demir-Cakan, N. Baccile, M. Antonietti, M.M. Titirici, Chem. Mater., 21 (2009) 484-490.
[2] M. Wu, Y. Wang, D. Wang, M. Tan, P. Li, W. Wu, N. Tsubaki, J. Porous Mater., 23 (2016) 263-271.

Photocatalytic degradation of water organic pollutants

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Photocatalysis has attractive potential applications in many areas such as conversion of solar energy into chemical energy (e.g., hydrocarbon/ hydrogen fuel) as well as an emergent advanced oxidation technique to remove pollutants from wastewater and/or air. Many nanocrystalline semiconductors have been explored and examined in detail for their use possibilities in this area.[1,2]

Titanate nanotubes (TNT) are commonly used in photocatalysis due to their high surface area, which provides ease of reaction and interaction mainly on the catalyst surface. We this in mind we doped TNT with Zn(II) complexes and investigated their photocatalytic activity in water. TNT were synthesised hydrothermally at 160 °C for 46 h in a sealed autoclave. The nanotubes were characterised by powder X-ray diffraction, transmission electron microscopy and both UV-vis and FTIR spectroscopy. The nanotubes were doped with Zn(II) complexes (**1** and **2** – Figure 1) and the effect of post-doping treatments investigated (e.g. effect of pH on the catalyst properties). The catalytic activity of these new hybrid materials on the photodegradation of common water pollutants was investigated through the evaluation of hydroxyl radical formation using the terephthalic acid as probe.

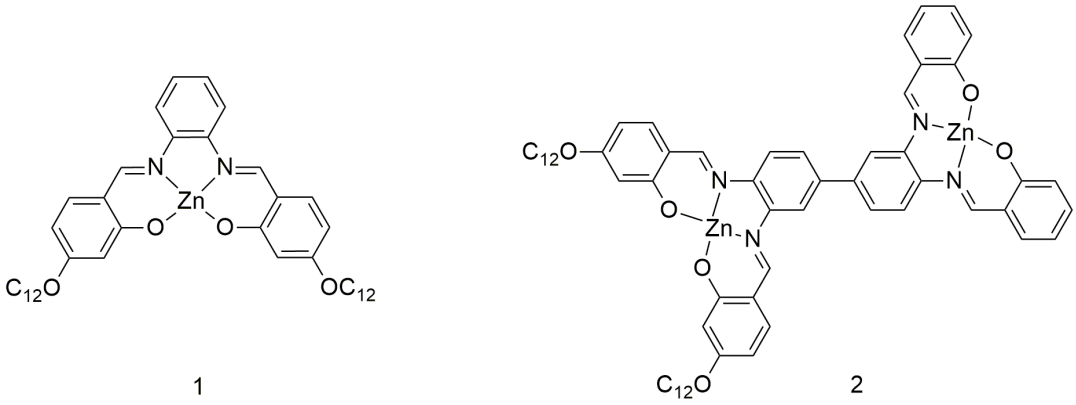

Figure 1. Complexes used to dope TiO_2 nanotubes.

Acknowledgements

The authors thank Fundação para Ciência e Tecnologia for financial support (UID/MULTI/00612/2013) and fellowships to PNM (SFRH/BPD/73345/2010) and SR (PD/BD/52368/2013).

[1] J. Schneider, M. Matsuoka, M. Takeuchi, J. Zhang, Y. Horiuchi, M. Anpo, D. W. Bahnemann, Chem. Rev. 114 (2014) 9919-9986.

[2] S. Girish Kumar and L. Gomathi Devi, J. Phys. Chem. A 115 (2011) 13211-13241.

Tuning the pore size distribution of mesoporous carbons: the key role of alkaline chlorides in mixtures with zinc chloride

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Activated carbons are unique materials due to their high adsorption properties, tuneable pore size distribution and rich surface chemistry, being so crucial in various industrial processes. But, the sustainability, stability and versatility of these materials still stimulates continuous efforts in the development of improved or new synthetic routes leading to better performances or even new properties. Particularly, the synthesis of mesoporous carbons has had significant advances in the last decades, due to their importance in applications involving large molecules, such as, adsorbents for dyes, catalyst supports for biomolecules, or as electrodes for biosensors [1].

A recent study reported the synthesis of highly mesoporous carbons from biomass using a eutectic salt mixture $KCl/ZnCl_2$, attaining $A_{BET} \approx 1300$ m^2 g^{-1} with more than 90 % of mesopores [2]. The present work aims to explore the potentialities of alkaline and zinc chlorides mixtures, as porogens for the control of the mesopore size distribution in glucose-derived activated carbons. The activation was made with eutectic mixtures of $LiCl/ZnCl_2$ (LiZn), $NaCl/ZnCl_2$ (NaZn) and $KCl/ZnCl_2$ (KZn), and also only with $ZnCl_2$ for comparison purposes. Briefly, 1 g of glucose was milled with 3 g of the salt mixture being activated under N_2 flow (5 cm^5 s^{-1}): up to 240 °C (10 °C min^{-1}), which was kept for 2 h, further increased up to 800 or 1000 °C (10 ºC min^{-1}), then held for more 2 h. The furnace was cooled (N_2 flow), sample was washed with distilled water until no detection of chlorine ions in the supernatant, dried and stored. Characterization was made by N_2 adsorption isotherms at -196 °C, ash content, determination of the pH at the point of zero charge (pH_{PZC}) and DRIFT.

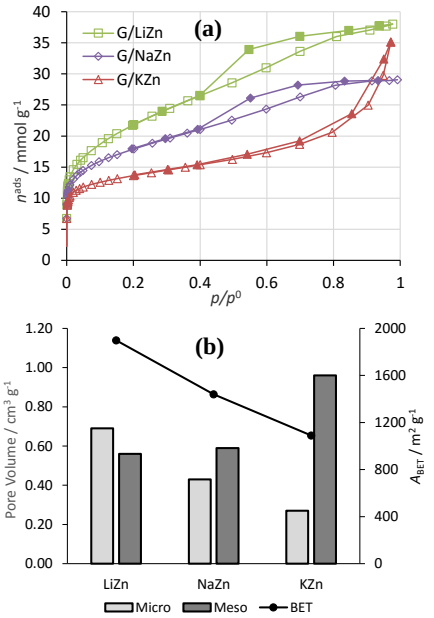

Figure 1. Textural characterization of materials obtained at 800 °C with the mentioned eutectic mixtures (a) N_2 isotherms; (b) textural parameters (bars: volumes; line: A_{BET}).

Salt mixtures play a crucial role in the porosity development as illustrated in the N_2 adsorption isotherms shown in Fig. 1(a). All curves belong to the type IV(a) according to the IUPAC classification [3], being characteristic of mesoporous solid materials. Samples obtained with the eutectic salt mixtures LiZn and NaZn present type H2(b) hysteresis loops associated with pore blocking and broad distribution of neck widths, sample prepared with KZn has a type H4 hysteresis loop usually found in micro-mesoporous carbons.

In all cases superactivated carbons were obtained (total pore volumes (V_{total}) ≥ 1 cm^3 g^{-1} and 1000 < A_{BET} < 2000 m^2 g^{-1}) (Fig. 1(b)). The materials have well developed micro and mesopore networks, with V_{meso} accounting to 45-60 % of the V_{total} when LiZn and NaZn were used, and reaching 80 % when KZn was employed. Sample prepared only with $ZnCl_2$, in the same amount of $ZnCl_2$ used in the eutectic mixture KZn, has the double of the A_{BET} but only 18 % of V_{meso}, proving that alkaline metals play a fundamental role in the development of pores in this methodology. The results obtained so far reveal that the mesopore size distribution can be tuned by the salt mixture: LiZn leads to materials with high V_{meso} with small diameters (2 – 10 nm; NaZn originates mesopores up to 20 nm, and KZn results in high volume of large mesopores (20 – 50 nm).

Acknowledgements
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[1] J. Lee, J. Kim, T. Hyeon, Adv. Mater. 18 (2006) 2073-2094.
[2] Z. Ma, H. Zhang, Z. Yang, Y. Zhang, B. Yu, Z. Liu, J. Mater. Chem. A 2 (2014) 19324-9.
[4] M. Thommes, K. Kaneko, A.V. Neimark, J.P. Olivier, F. Rodriguez-Reinoso, J. Rouquerol, K.S.W. Sing, Pure Appl. Chem. 87 (2015) 1051-1069.

Influence of abiotic effects on antioxidant and polyphenol content of some economically valuable Mediterranean crops

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Many economically valuable plants are used in folk medicine due to its antioxidant properties which are usually a consequence of its high content in phenolic compounds. However, the antioxidant properties depicted by many medicinal plants are not an intrinsic property but are usually highly affected by abiotic factors.

Fenugreek (*Trigonella foenum-graecum*) is an annual Leguminosae crop, cultivated throughout the world especially in India, in Middle Eastern countries, and widely in the Mediterranean basin including Tunisia. It has many effects on health. Leaves and seeds of Fenugrec are used in ethnomedicine due to its anti-oxidant, antidiabetic, antimicrobial, anti-inflammatory, etc, activities. Nowadays, contamination by heavy metals (such as arsenic, zinc, cadmium, cobalt, aluminium, lead...) has adverse effects on the mobilization of mineral, organic reserves and growth of plants and causes many problems on health. In this communication it is presented the effect of zinc and arsenic on the antioxidant properties and phenol content of methanol extracts of fenugreek cultivated under these metal stress and also the effect of salicylic acid used to counteract these adverse conditions. Antioxidant properties were investigated following the bleaching of the DPPH radical during 60 minutes (Figure 1). As it can be seen in Figure 1 all extracts were mildly active, have either been prepared from the leaves or the roots. Metal stress (ZR, AR, ZF and AF extracts) increased the production of antioxidant compounds comparing with non treated plants (TR and TF). Polyphenol content was highly affected by treatments and results will be presented and discussed.

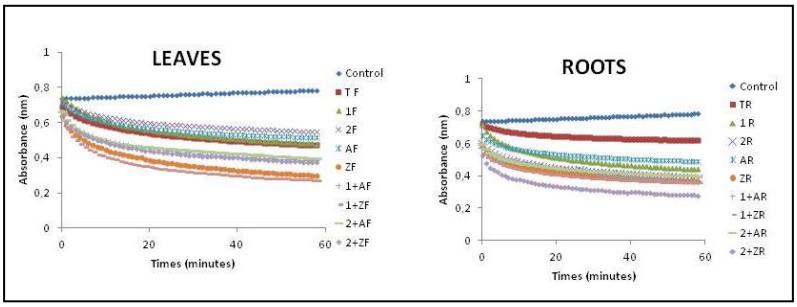

Figure 1. Bleaching of DPPH radical by methanol extracts of leaves and roots of non treated (TR, TF) and treated plants

Sumac, *Rhus coriaria* L. is another important plant that grows in the Mediterranean basin. Is a small shrub from the Anacardian family whose fruits are used as condiment and whose leaves were traditionally milled and used in leather production and as a mordent in textile dying due to its high content in gallotanins. Two samples of sumac, one collected in North of Portugal and the other a commercial one from Italian origin were compared (Table 1).

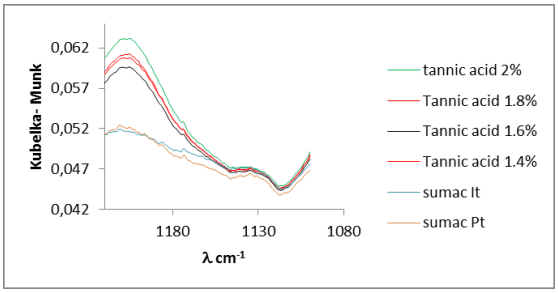

Figure 2. ATR-FTIR spectra of tannic acid and sumac

Tannin content was obtained integrating the ATR-FTIR absorbance band at 1209 cm^{-1} of aqueous solutions of tannic acid with several concentrations. The band at 1209 cm^{-1} is a band common to all tannins, and very important in gallotannin spectra (Figure 2) [1].

Table 1. Antioxidant, total phenolic content and tannin content of sumac

Sumac origin	EC_{50} (mg/mL, DPPH test)	TPC (GAE)*	TC**
Portuguese	4.2	62.7	558
Commercial	9.3	39.9	386

* TPC: total phenolic content; GAE: galic acid equivalents, mg/g extract;**TC: tannin content, tannic acid equivalents mg/g extract

Acknowledgements

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[1] L. Falcão, M. E. M. Araújo, Vibrational Spectroscopy 74 (2014) 98.

Step by step development of a lipid-based immunosensor platform with high capability to inhibit nonspecific adsorption

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To detect the presence of a particular bioanalyte (e.g. a tumor biomarker), usually in low concentration and in complex matrices, a biosensor with both high affinity and selectivity must be employed, avoiding nonspecific interactions between those molecules and the biosensor components [1]. These requirements can be achieved using immunosensor interfaces, where the sensitive biological elements are antigens or antibodies immobilized on a surface and the formation of the complex antigen-antibody generates a measurable signal [2]. Regarding nonspecific interactions, our recent work has given support to the developing notion that lipid biointerfaces are very effective to suppress them, and that this feature, allied with their biocompatibility, represents an additional advantage to the development of immunosensing devices [3].

Here, we present the design and assembly of a highly organized and stable immunosensing interface with special capability to inhibit the nonspecific adsorption of proteins, enhancing the signal generated by the recognition event and thus the limit of detection. Several characterization techniques were employed during the implementation of this bottom-up approach. Conventional ellipsometry was used to estimate gold substrates thickness as well as for the screening of each step of the immunosensor development. Atomic force microscopy allowed the direct visualization of the modified surfaces during the process. Total internal reflection imaging ellipsometry, as well as surface plasmon resonance, were selected to perform the biosensing assays with the antibodies in order to evaluate the performance of the platform developed.

The developed interface consists of a gold surface modified with a self-assembled monolayer of 11-amino-1-undecanethiol, which contains terminal amine groups that were used to covalently link modified lipid molecules (1-myristoyl-2-(14-carboxymyristoyl)-*sn*-glycero-3-phosphocholine), through the terminal carboxylic groups previously activated. 2-hydroxyoleic acid molecules were added to the lipid monolayer to provide oriented carboxylic groups to covalently link Immunoglobulin G (IgG). The performance of the interface was evaluated by the real-time detection of Anti-IgG-IgG complex formation.

Acknowledgments

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[1] S. Gs, A. Cv, and B. B. Mathew, *Journal of Instrumentation Technology*, 2 (2014) 26-39.

[2] Y. Niu, A. I. Matos, L. M. Abrantes, A. S. Viana, and G. Jin, *Langmuir*, 28 (2012) 17718-25.

[3] I. Almeida, J. T. Marques, W. Liu, Y. Niu, R. F. de Almeida, G. Jin, *A. S. Viana*, *Colloids Surf B: Biointerfaces*, 136 (2015) 997-1003.

Thermochemistry of peroxy radicals: a combined photoacoustic calorimetry, quantum chemistry and molecular dynamics study

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Reaction 1, where R• denotes a carbon radical and ROO• the product peroxy radical, is a key step in the interaction mechanism of oxygen with organic matter, hence its enormous importance. Its study is essential, for instance, to optimize the production of energy (and thus limit emissions) from internal combustion engines, or to develop antioxidants to avoid the deterioration of cellular membranes due to lipid peroxidation.

$$R^{\bullet} + O_2 \rightleftarrows ROO^{\bullet} \qquad (1)$$

To fully describe the thermodynamics of reaction 1, we need to know the stability of both the carbon and peroxy radicals. However, the energetics of radicals can be notoriously difficult to study. While the thermodynamic stability of long-lived organic molecules is well established for a large number of substances [1], only a few hundreds of carbon radicals are listed in a recent compilation of thermochemical data [2], and the situation is particularly critical for peroxy radicals: the same compilation includes less than 30! The need for further research on the subject is evident but, to study such demanding species, one needs to use advanced experimental or theoretical techniques (or preferably, both).

Time-resolved photoacoustic calorimetry (TR-PAC) is a recent technique suited to study radical reactions, in which they are started with a laser (photo-) and then followed via a microphone (-acoustic). In this way the radicals can be "temporally isolated", which allows probing their thermochemistry with chemical accuracy (ca. 5 kJ/mol). Regarding computational chemistry methods, the accuracy of composite approaches together with the explicit treatment of electronic correlation [3] is comparable to the best conventional methods but, unlike those, it can be used for much "larger" systems (in electron number, such as the peroxy radicals). Finally, molecular dynamics (MD) is essential for the interpretation of the above results at a molecular level, bridging the experimental and electronic structure data.

In this work we will present our methodology to study the above reaction, together with experimental and computational results for the thermochemistry of selected carbon and peroxy radicals. The interpretation of the TR-PAC results for peroxy radicals is complicated by some still poorly understood issues, namely the volume change and the solvation effects of reaction 1. Both these problems can be conveniently addresses by MD. Still, fundamental aspects of this procedure need to be addressed, such as the development of suitable force-fields for the radicals. These subjects, which were neglected in previous studies of reaction 1 [4], will also be discussed and presented as part of our complete and accurate methodology for the experimental and computational study of the thermochemistry of peroxy radicals.

Acknowledgements

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[1] P. J. Linstrom, W. G. Mallard. NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology Gaithersburg MD, http://webbook.nist.gov.
[2] Y.-R Luo, Comprehensive Handbook of Chemical Bond Energies. CRC Press: Boca Raton, 2007.
[3] A. Karton, J. M. L. Martin, J. Chem. Phys. 136 (2012) 136 124114.
[4] M. Kranenburg, M. V. Ciriano, A. Cherkasov, P., Mulder, J. Phys. Chem. A 104 (2000) 915-921.

The impact of ligand derivatisation on Mn(III) thermal spin transitions

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Spin crossover (SCO) compounds which can switch between two magnetic states are magnetic materials with good potential for incorporation into spintronics.[1] Magnetism in transition metal ions arises from unpaired spins residing in *d*-orbitals. Careful ligand design produces molecules able to reversibly switch between the two possible electronic spin states, HS and LS. Switching between different magnetic states in a single molecule is then achievable by heat, light or pressure stimulus. Hysteretic SCO complexes represent a very rare example of bistability in single molecules which normally have just one stable electronic state under ambient conditions.[2]

In Mn(III) complexes with $N_4(O^-)_2$ donating Schiff-bases the modulation of the orientation of the $N_4(O^-)_2$ donors in a series of hexadentate ligands had a dramatic effect on the spin state of their Mn(III) complexes. The continuous search for new examples of SCO complexes with spin transitions around room temperature, and also for systems showing a high degree of cooperativity, led us to further investigate new examples of d^4 Mn(III) complexes with this ligand series. Like Fe(III), Mn(III) also may present two paramagnetic spin states with LS (S = 1) and HS (S = 2) states but with permanent distortion in the HS state due to a strong Jahn-Teller effect.

We report a series of complexes derived from the polyamine 1,2-bis(3-aminopropylamino)ethane which reacted with salicylaldehyde to form the hexadentate Schiff-base ligands. This ligand formed the mononuclear Mn(III) complexes by reaction with different $MnY_2 \cdot xH_2O$ salts (Y = BF_4^- , ClO_4^- , BPh_4^- and PF_6^-) after air oxidation. All compounds were characterized by FTIR, UV-Vis and NMR spectroscopies, elemental analysis and single crystal X-ray crystallography. Magnetic measurements on all compounds were also performed.

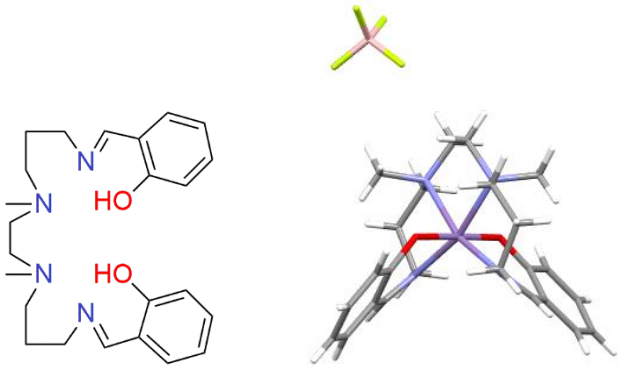

Figure 1 – Schiff-base ligand used in this study (left) and single crystal X-ray structure of the Mn(III) BF_4^- salt (right).

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[1] Feringa, B. L. *Molecular Switches*; Wiley-VCH Verlag GmbH, 2001.
[2] Martinho, P. N., Gildea, B., Harris, M. M., Lemma, T., Naik, A. D., Müller-Bunz, H., Keyes, T. E., Garcia, Y., Morgan, G. G., Spin Transitions, 2012, 51, 12597-12601.

Recovery of palladium from a spent industrial catalyst: A hydrometallurgical approach

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Platinum-group metals (PGMs) are nowadays a trademark of several top technological devices, their unique properties being extensively explored in medicine applications, in the manufacture of electronic materials and fuel cells, and particularly as catalysts (in automotive catalytic converters, oil refining and fine chemistry processing). To prevent ore exhaustion due to current and extensive industrial demand, since mineral deposits of PGMs are scarce in the earth surface, the development of recycling practices suited to end-of-life materials (the so-called urban mining) has become a real necessity [1].

In this communication the development of an integrated hydrometallurgical treatment applied to a spent hydrogenation catalyst from a Portuguese petrochemical industry – Figure 1 – is described. The spent catalyst, composed by alumina with 0.03% palladium and 0.03% chromium, has been leached under different experimental conditions, for which the parameters taken into account were the nature and concentration of the leaching agents, temperature, time, liquid/solid ratio (L/S) and particle size. The system showing the maximum Pd solubilisation and the minimal dissolution of Al and Cr consisted on 2M HCl and 1M H_2O_2, 27ºC, 10 min, L/S=2 L/kg and an average 176 µm of particle size – Table 1.

Figure 1. Spent catalyst sample used in this work.

Table 1. Composition of the "best" leaching solution.

	[Pd] / mgL^{-1}	[Al] / gL^{-1}	[Cr] / mgL^{-1}
2M HCl +1M H_2O_2	63.00 ± 2.00	2.92 ± 0.10	0.40 ± 0.05

The leaching solution was subject to solvent extraction (SX) with two thiodiglycolamide derivatives in toluene. It is well known that *N,N'*-dimethyl-*N,N'*-dicyclohexylthiodiglycolamide (DMDCHTDGA) [2] and *N,N'*-dimethyl-*N,N'*-dibutylthiodiglycolamide (DMDBTDGA) [3] are able to efficiently and selectively extract Pd(II) from HCl solutions, 0.1M thiourea in 1M HCl being used as stripping agent to transfer the PGM to new aqueous phases.

The practical usefulness of these SX systems has been accessed by: a) DMDCHTDGA and DMDBTDGA consecutive Pd extraction-stripping cycles with the leaching solution, to test their robustness upon reutilization; b) The plot of the correspondent equilibrium extraction isotherms, to evaluate the maximum Pd(II) loading capacity. The overall results obtained show that both thiodiglycolamide derivatives are re-utilizable, maintaining their efficiency for Pd(II) recovery after several cycles, although the progressive accumulation of Al in the solvents may be a drawback. The co-extraction of Al also affects the loading capacity of the organic solvents towards Pd(II), since they are not so high as expected, due to the negative interference of Al.

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[1] S. Steinlechner, J. Antrekowitsch, JOM 67 (2015) 406–411.
[2] O. Ortet, A.P. Paiva, Sep. Purif. Technol. 156 (2015) 363–368.
[3] O. Ortet, M.E. Martins, A.P. Paiva, Metals 5 (2015) 2303–2315.

"Healthy Life": Interaction of polyphenols with lipid bilayers and their effects in human cells

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This work concerns the transversal project of the CQB thematic line: "Healthy Life: Molecular Interventions and Regulation Mechanisms".

Biologically active plant phytochemicals have a broad range of pharmacological effects including anticarcinogenic, antimicrobial, antioxidant, and anti-inflammatory activity. [1] Notwithstanding the possibility of having a specific target, phytochemicals must interact and permeate through cell membranes in the body. Indeed, it was suggested that those molecules insert into the membranes and thereby may have a promiscuous activity by changing structural properties of lipid bilayers. [2]

Some well-known phenolic acids such as caffeic (CA), rosmarinic (RA) and chlorogenic (CGA) acids, whose identification in plant extracts has been achieved by CQB research groups, were selected to be addressed in first place (Figure 1).

All the phenolic acids studied have low lipophilicity and among them, RA was the only one with a partition to biological membrane models measurable by fluorescence spectroscopy, as opposed to CA and CGA. Cyclic voltammetry measurements using an electrode modified with a supported lipid bilayer, also indicated a higher affinity of RA to lipid membranes. In addition, oxidation/reduction of the phenolic acids displayed higher reversibility in the lipid milieu than in the aqueous bulk. Indeed, the reduced form of phenolic acids was unstable in aqueous solution. In particular, in DMEM/F-12 cell culture media, a colour change observed after incubation with each compound could be reverted by the addition of a reducing agent. The higher reversibility of phenolic acids oxidation/reduction, once they were inserted in the lipid membrane, may contribute to the stability of the compounds and prevent the formation of degradation products. Molecular dynamics (MD) simulations are being performed to probe the location and orientation of these and other selected compounds in lipid bilayers.

The influence of the phenolic acids in the cytoskeleton organization, both actin filaments and microtubules, of a human retinal pigment epithelial cell line (RPE1) was also investigated. All compounds induced concentration and time dependent effects, translated in structural alterations mainly at the cell periphery, and also in the perturbation of cell division. Moreover, it was not evident that these compounds induce apoptosis under the conditions tested. RA seemed to induce evident effects at earlier times and at lower concentrations, as compared to CA and CGA. This higher sensibility of RPE1 cells to RA correlates with the higher affinity of this compound to the lipid bilayer.

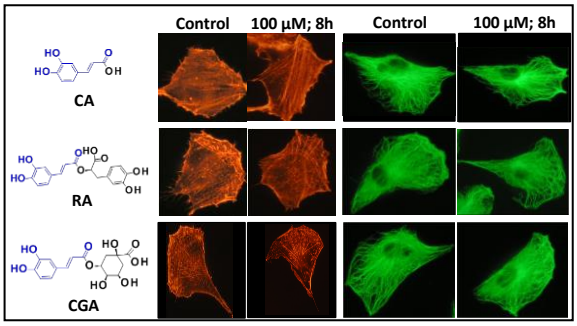

Figure 1. Effects in the actin filaments (red) and microtubules (green) of RPE1 cells, after 8 h incubation with 100 µM of phenolic acid.

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[1] A. Stefanson and M. Bakovic, Nutrients 6 (2014) 3777-3801.

[2] H. I. Ingólfsson, P. Thakur, K. F. Herold, E. A. Hobart, N. B. Ramsey, X. Periole, D. H. de Jong, M. Zwama, D. Yilmaz, K. Hall, T. Maretzky, H. C. Hemmings, C. Blobel, S. J. Marrink, A. Koçer, J. T. Sack and O. S. Andersen, ACS Chem. Biol. 9 (2014) 1788-17

"Designing" porous networks for water treatment: Removal of atenolol and antibiotics by activated carbons

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Continuous release of antibiotics into the environment could exert pressure on ecosystem by developing microbial antibiotic resistance leading to public health important issues. These drugs are only partially absorbed by the body, reaching domestic wastewater and, since the conventional wastewater treatment processes are ineffective in removing these compounds, they are continuously introduced in the aquatic system [1-3]. To solve this problem, advanced technologies, such as adsorption onto carbon materials, have been developed. However, high cost restricts the application of these materials, boosting researchers to explore the preparation of carbons from waste materials or renewable sources [4].

The objective of this work was to prepare activated carbons from the char of apple tree bark residues and evaluating the influence of different experimental conditions in the textural properties of the materials. Selected samples were tested as adsorbents of a β-blocker medicine (atenolol), and two antibiotics (tiamulin fumarate and oxytetracycline hydrochloride).

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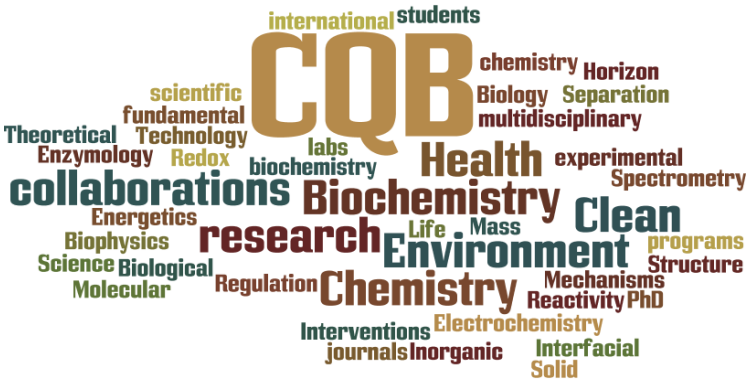
REFERENCES

[1] A.M. Pereira, L.J. Silva, L.M. Meisel, A. Pena, J Toxicol Env Health 78 (2015) 959-975.
[2] J. L. Sotelo, A. Rodríguez, S. Álvarez, J. García, Int J Environ Res 6(4) (2012) 961-968.
[3] M. Pomorska-Mól, C Kowalski, J Liq Chromatogr R T 32 (2009) 1023-1031.
[4] A.S. Mestre, E. Tyszko, M.A. Andrade, M. Galhetas, C. Freire, A. P. Carvalho, RSC Adv 5 (2015) 19696-19707.



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