Title: Effect of the number of shells on the pressure and energy of two-dimensional free bubble clusters

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Abstract: We have performed Surface Evolver simulations of two-dimensional hexagonal bubble clusters consisting of a central bubble of area lambda surrounded by s shells or layers of bubbles of unit area. Clusters of up to twenty layers have been simulated, with lambda varying between 0.01 and 100. In monodisperse clusters (i.e., for lambda = 1) [M.A. Fortes, F Morgan, M. Fatima Vaz, Philos. Mag. Lett. 87 (2007) 561] both the average pressure of the entire Cluster and the pressure in the central bubble are decreasing functions of s and approach 0.9306 for very large s, which is the pressure in a bubble of an infinite monodisperse honeycomb foam. Here we address the effect of changing the central bubble area lambda. For small lambda the pressure in the central bubble and the average pressure were both found to decrease with s, as in monodisperse clusters. However, for large,, the pressure in the central bubble and the average pressure increase with s. The average pressure of large clusters was found to be independent of lambda and to approach 0.9306 asymptotically.

We have also determined the cluster surface energies given by the equation of equilibrium for the total energy in terms of the area and the pressure in each bubble. When the pressures in the bubbles are not available, an approximate equation derived by Vaz et al. [M. Fatima Vaz, M.A. Fortes, F. Graner, Philos. Mag. Lett. 82 (2002) 575] was shown to provide good estimations for the cluster energy provided the bubble area distribution is narrow. This approach does not take cluster topology into account. Using this approximate equation, we find a good correlation between Surface Evolver Simulations and the estimated Values of energies and pressures. (C) 2008 Elsevier B.V. All rights reserved.

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