

Abstract Submitted
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Origins of the Failure of Classical Nucleation Theory for Nanocellular Polymer Foams¹ RUSSELL THOMPSON, YEONGYOON KIM, University of Waterloo — The behavior of nanocellular polymer foams, in which nanometer-sized bubbles of fluid are dispersed in a polymer matrix, is dominated by its internal surfaces. In particular, nucleation of a nanocellular foam can involve fundamentally different physics from microcellular or regular foams due to properties of the surfaces. Nucleation rates for nano-bubbles in polymer have been calculated using both classical nucleation theory and self-consistent field theory. An identical model is used for both calculations showing that classical nucleation theory predictions are off by many orders of magnitude. The cause of the failure of classical nucleation theory can be traced primarily to its representation of a bubble surface as an infinite planar interface. For nanoscopic bubbles, the curvature of the bubble surface is comparable to the size of the polymer molecules. Polymers on the outside of a curved bubble surface can explore more conformations than can polymers next to a flat interface. This results in a lower free energy for the curved interface system with respect to a flat interface system, which gives a significantly smaller barrier energy to nucleation and thus a much higher nucleation rate.

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Russell Thompson
University of Waterloo

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