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Nucleation-Mode Localization in Hard-Soft Nanocomposites[1]
RALPH SKOMSKI, BALAMURUGAN BALASUBRAMANIAN, BHASKAR DAS, D. J. SELLMYER, Department of Physics and Astronomy and NCMN, University of Nebraska — Aligned hard-soft nanocomposites continue to be an active research area in permanent magnetism, challenged by demanding processing requirements but also encouraged by experimental proofs of principle. The approach was initially outlined by Kneller and Hawig (1991), who advocated hard-soft multilayers. Skomski and Coey (1993) considered three-dimensional nanostructures, such as soft spheres in a hard matrix, and predicted an upper energy-product limit of about 1000 kJ/m^3. It is well-established that the dimensions of the soft regions cannot be larger than twice the domain-wall width of the hard phase, but otherwise it was believed that geometry has a rather secondary effect. However, our recent research reveals substantial differences. Soft-in-hard geometries are better than hard-in-soft geometries and embedded soft spheres are better than multilayers. This is in close analogy to the dimensionality-dependent quantum-mechanical delocalization of electrons in an inhomogeneous potential and to the behavior of impurity states in the band gaps of solids. Transparent analytical nucleation-field solutions are found for some geometries and in the limit of very small soft inclusion as a function of the hard-phase coercivity and hysteresis-loop shape.

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Ralph Skomski
Department of Physics and Astronomy and NCMN, University of Nebraska

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