THE MAGNETIC PROPERTIES OF 2D NANO ISLANDS: AN ISING SPIN MODEL

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9.7 cm

An Ising spin effective field theory (EFT) is developed for a detailed analysis of the magnetic properties of 2D nano islands on non-magnetic substrates. The Hamiltonian consists of nearest neighbor exchange interactions and single-atom magnetic anisotropy, with spin $S = 1$. The model is general, for different nano island lattices, and permits analysis of spin fluctuations. Our calculations yield the single site spin correlations, magnetizations, and isothermal susceptibilities for the nano island core and periphery domains which are structurally distinct. In particular we investigate the effects due to the remarkably different domain anisotropies over their reduced dimensionalities, with detailed theoretical results for the square and hexagonal lattices, and numerical applications for Co nano islands on Pt. Though both the core and the periphery domains have the same order-disorder transition temperature, the magnetization of each attains this transition differently. The temperature behaviors of the spin correlations are also fundamentally different for periphery and core domains, generating distinctly different isothermal susceptibilities. The calculated overall nano island susceptibilities do not correspond to second order phase transitions. Furthermore, our EFT Ising model correctly interprets the susceptibility data for Co nano islands on Pt without reference to a transition from a blocking state to a superparamagnetic behavior.

13.4 cm

Subject category :

3. Magnetic Structure and Dynamics

Presentation mode :

poster

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