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Characterization of the 2D percolation transition in ultrathin Fe/W(110) films using the magnetic susceptibility

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The growth of the first atomic layer of an ultrathin film begins with the deposition of isolated islands. Upon further deposition, the islands increase in size until, at some critical deposition, the merging of the islands creates at least one connected region of diverging size. This universal phenomenon describing connectivity is termed "percolation"and occurs at a "percolation transition"that can be described in renormalization group theory. In the context of a 2-dimensional ultrathin ferromagnetic film, geometric percolation can be monitored through the magnetic susceptibility, since as the island size diverges so does the correlation length of the ferromagnetic state. Although much work has been done studying films of known deposition as a function of temperature to detect percolation, very little work has characterized the transition as it occurs as a function of deposition at constant temperature. We report on measurements of the magnetic susceptibility, using the surface magneto-optic Kerr effect (SMOKE) under ultrahigh vacuum (UHV), as a function of deposition (at constant temperature) for the Fe/W(110) system as the first atomic layer is formed. Two regimes were detected: a high temperature regime with a broad susceptibility peak at larger depositions that represent a standard Curie transition from paramagnetism to ferromagnetism in a continuous film, and a low temperature regime with a much sharper peak in the susceptibility that occurs at the same deposition regardless of temperature. The low temperature regime is a good candidate for a geometric 2-dimensional percolation transition. Preliminary analysis gives a percolation critical exponent of $\gamma = 2.4 \pm 0.2$, in agreement with the result from the 2D Ising model.

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