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Models for Particle growth

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The fate of an adsorbed atom on a substrate, as revealed by atomic scale measurements, could be to find one or more diffusing atoms and nucleate to form a new island or to find an existing island and get incorporated [1, 2]. Not only small groups of atoms but large groups comprising of several hundred atoms have also been found to be mobile, but with a lower mobility [3]. Desorption of a single atom or fragmentation of a bit of mass from a larger island are other identified mechanisms resulting in island size depletion. Thus the growth process is highly non-equilibrium, leading to ever evolving islands. These observations have provided an impetus to theoretical modeling of particle and surface growth phenomena. Identifying microscopic growth mechanisms as well as parameters influencing them in order to be able to control the morphology and size-selection of islands is a topic of great contemporary interest.

We study the effect of varying the adsorption rate, deposition time and temperature on the formation of $Pb_{1-x}Fe_xS$ and Pd nanoparticle films in an attempt to identify microscopic processes which contribute towards their growth [4, 5]. Computer simulations of a stochastic lattice model with the basic mechanisms of adsorption, diffusion and irreversible aggregation have been performed to mimic the underlying mechanism of particle growth. We propose a mass and temperature dependent diffusion term of the form D(m,T) $\propto D_o(T)m^{-\gamma}$ in order to obtain qualitative agreement with experimental data. The possibility of tuning adsorption rate, deposition time and temperature to obtain narrow particle size distributions is explored. Aspects of scaling and self-similarity in the particle growth are analyzed for the nanoparticle films by performing TEM studies [4] as well as calculations of fractal dimensions [6]. Where ever pertinent, simple analytical arguments are presented.

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