Rate-equation approach to irreversible island growth with cluster diffusion

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University of Toledo — A self-consistent rate-equation (RE) approach to irreversible island growth and nucleation is presented which takes into account the effects of cluster mobility. As a first application we consider the irreversible growth of compact islands on a 2D surface in the presence of monomer deposition (with rate \( F \)) and monomer diffusion (with rate \( D_1 \)) while the mobility of an island of size \( s \) is assumed to satisfy \( D_s = D_1 s^{-\mu} \) where \( \mu \geq 0 \). For coverages up to the peak island-density, we find excellent agreement between our RE and simulation results for the dependence of the island-density \( N(\theta) \) on coverage \( \theta \) for all values of \( \mu \) considered, ranging from \( \mu = 1/2 \) (Brownian motion) to \( \mu = \infty \) (immobile clusters). For \( \mu \leq 2 \), excellent agreement is also found between our simulation and RE results for the island-size distribution (ISD), while for higher values of \( \mu \) the effects of correlations become important. We also demonstrate that the discrepancies between recent theoretical predictions for the exponents \( \tau(\mu) \) and \( \zeta(\mu) \) describing the size-dependence of the ISD for \( \mu < 1 \) and simulations can be explained by the geometry of compact islands. Our self-consistent RE approach may also be generalized to higher dimensions as well as to an arbitrary dependence of the cluster mobility on island-size.