

Numerical Simulation of Slope-Selection Epitaxial Thin-Film Growth

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Abstract

Slope-selection epitaxial thin-film growth gives rise to a variationally structured, energy-dissipative dynamical system. When this system is formulated within a phase-field framework, the resulting evolution equation exhibits complex coarsening dynamics that unfold over very long time scales and are closely related to experimentally observed hill-and-valley structures. Capturing such dynamics poses significant challenges for numerical simulation, particularly in maintaining correct energy dissipation and structural consistency over long times. In this work, we develop a second-order, linear, and energy-stable scheme that preserves the intrinsic dissipative structure of the model at the discrete level. Numerical simulations demonstrate that the scheme robustly resolves long-time coarsening dynamics and accurately recovers physically relevant scaling laws.