

Unified moving-boundary model with fluctuations for unstable diffusive growth

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Abstract-

We study a moving-boundary model of nonconserved interface growth that implements the interplay between diffusive matter transport and aggregation kinetics at the interface. Conspicuous examples are found in thin-film production by chemical vapor deposition and electrochemical deposition. The model also incorporates noise terms that account for fluctuations in the diffusive and attachment processes. A small-slope approximation allows us to derive effective interface evolution equations (IEEs) in which parameters are related to those of the full moving-boundary problem. In particular, the form of the linear dispersion relation of the IEE changes drastically for slow or for instantaneous attachment kinetics. In the former case the IEE takes the form of the well-known (noisy) Kuramoto-Sivashinsky equation, showing a morphological instability at short times that evolves into kinetic roughening of the Kardar-Parisi-Zhang (KPZ) class. In the instantaneous kinetics limit, the IEE combines the Mullins-Sekerka linear dispersion relation with a KPZ nonlinearity, and we provide a numerical study of the ensuing dynamics. In all cases, the long preasymptotic transients can account for the experimental difficulties in observing KPZ scaling. We also compare our results with relevant data from experiments and discrete models.

Index Terms-

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