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FOR 845

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Simulations and experiments of ion beam patterning in the linear instability regime

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The linear instability mechanism offers a simple paradigm for explaining how different kinetic processes interact to determine the evolution of ion-bombarded surfaces. By starting from fundamental surface processes such as sputtering, defect formation and surface transport, it presents a physically intuitive model that makes testable predictions about how the early stages of pattern formation depend on the processing conditions.

To explore the validity of the linear instability approach, we have performed kinetic Monte Carlo simulations and experimental measurements of pattern evolution to compare with the model predictions. In particular, we focus on the temperature and flux dependence of the ripple growth rate and wavelength. We also describe a kinetic phase diagram as a way to organize multiple experimental observations in a coherent framework based on the different processing regimes.

Although the linear instability captures many features of real systems, there are also many aspects of patterning that are not well understood. In the final section of the talk, we describe additional roughening mechanisms that may explain why surfaces are observed to ripple faster than predicted by the instability model. Finally, we describe some new patterning formation behavior predicted in alloys.