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Interplay between morphology and surface transport in nanopatterns produced by ion-beam sputtering

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Abstract— A "hydrodynamic" model has been proposed to describe nanopattern formation and dynamics on amorphous surfaces eroded by ion-beam sputtering (IBS), that relates to descriptions of pattern formation in macroscopic systems such as aeolian sand dunes. At variance with previous continuum models of the morphology of ion-sputtered surfaces, the dynamics of the species that diffuse along the surface is coupled in a natural way to that of the surface height. We report recent results for this model, considering normal and oblique ion incidence, for both fixed and rotating targets, and include comparison to recent experiments on silicon. Effective interface equations can be obtained, that generalize the anisotropic Kuramoto-Sivashinshy equation through additional conserved Kardar-Parisi-Zhang type nonlinear terms. In general dot or ripple patterns form, that later evolve exhibiting complex nonlinear dynamics. Thus, we observe interrupted coarsening behavior such that, for normal incidence, domains of hexagonally ordered structures appear, that compare favorably with those obtained in many experiments of nanodot formation by IBS. In other parameter regions, this short-range ordered patterns coexist with long range disorder and kinetic roughening. For oblique incidence, a ripple pattern is generically obtained that also shows interrupted coarsening and other nonlinear features like nonuniform transverse motion, again reproducing experimental observations.

Index Terms—

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