

Nonuniversality due to inhomogeneous stress in semiconductor surface nanopatterning by low-energy ion-beam irradiation

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Abstract-

A lack of universality with respect to ion species has been recently established in nanostructuring of semiconductor surfaces by low-energy ion-beam bombardment. This variability affects basic properties of the pattern formation process, like the critical incidence angle for pattern formation, and has remained unaccounted for. Here, we show that nonuniform generation of stress across the damaged amorphous layer induced by the irradiation is a key factor behind the range of experimental observations, as the form of the stress field is controlled by the ion/target combination. This effect acts in synergy with the nontrivial evolution of the amorphous-crystalline interface. We reach these conclusions by contrasting a multiscale theoretical approach, which combines molecular dynamics and a continuum viscous flow model, with experiments using Xe⁺ and Ar⁺ ions on a Si(100) target. Our general approach can apply to a variety of semiconductor systems and conditions.

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Citation:

Moreno Barrado, A.; Castro, M.; Gago, R.; Vázquez, L.; Muñoz-García, J.; Redondo-Cubero, A.; Galiana, B.; Ballesteros, C.; Cuerno, R. "Nonuniversality due to inhomogeneous stress in semiconductor surface nanopatterning by low-energy ion-beam irradiation", Physical Review B, vol.91, no.15, pp.155303-1-155303-12, April, 2015.