Applied Surface Science. Volume:258 Number: 9 Pages: 4171-4178. February 2012

Hydrodynamic approach to surface pattern formation by ion beams

M. Castro, R. Cuerno

Abstract— On the proper timescale, amorphous solids can flow. Solid flow can be observed macroscopically in glaciers or lead pipes, but it can also be artificially enhanced by creating defects. Ion Beam Sputtering (IBS) is a technique in which ions with energies in the 0.1-10 keV range impact against a solid target inducing defect creation and dynamics, and eroding its surface leading to formation of ordered nanostructures. Despite its technological interest, a basic understanding of nanopattern formation processes occurring under IBS of amorphizable targets has not been clearly established, recent experiments on Si having largely questioned knowledge accumulated during the last two decades. A number of interfacial equations have been proposed in the past to describe these phenomena, typically by adding together different contributions coming from surface diffusion, ion sputtering or mass redistribution, etc. in a non-systematic way. Here, we exploit the general idea of solids flowing due to ion impacts in order to establish a general framework into which different mechanisms (such as viscous flow, stress, diffusion, or sputtering) can be incorporated, under generic physical conservation laws. As opposed to formulating phenomenological interfacial equations, this approach allows to assess systematically the relevance and interplay of different physical mechanisms influencing surface pattern formation by IBS.

Index Terms— Ion Beam Sputtering; Hydrodynamics; Solid flow; Pattern formation; Stability; Viscous flow; Stress; Erosion

Citation:
Castro, M.; Cuerno, R.; "Hydrodynamic approach to surface pattern formation by ion beams", Applied Surface Science, vol.258, no.9, pp.4171-4178. February, 2012.