Nonlinear theory of ion-induced solid flow

Javier Muñoz-García[1], Rodolfo Cuerno[1,*], Mario Castro[2]

[1]Departamento de Matemáticas and Grupo Interdisciplinar de Sistemas Complejos (GISC), Universidad Carlos III de Madrid, Avenida de la Universidad 30, 28911 Leganés, Spain

[2]GISC and Grupo de Dinámica No Lineal (DNL), Escuela Técnica Superior de Ingeniería (ICAI), Universidad Pontificia Comillas, 28015 Madrid, Spain

**Email: cuerno@math.uc3m.es*

Nanopattern formation by ion beam sputtering (IBS) is a powerful technique employed to induce surface structures over relatively large areas for a wide range of materials.[1] This technique has many applications in modern technology like magnetic storage, quantum device design or, for example, producing the selective attachment of specific molecules to substrates, with implications in biology and catalysis. For materials like semiconductors that become amorphous under low-to-medium-energy irradiation, a description of IBS nanopatterning based on solid flow[2,3] has been proved to successfully explain many experimental observations.[4-6] This view of the process is based on the fact that, as a consequence of the impact of the ions and the subsequent release of energy within the target, residual stress is confined to a thin superficial amorphous layer and is eventually relaxed in macroscopic time scales via viscous flow. Previous viscous flow models have remained limited to the study of the initial (linear) stages of the morphology evolution. In this contribution, we present a nonlinear theory[7] that extends previous results and describes the dynamics of the morphology during subsequent, nonlinear stages of its time evolution.

References:

[1]J. Muñoz-García, L. Vázquez, M. Castro, R. Gago, A. Redondo-Cubero, A. Moreno-Barrado, and R. Cuerno, Mater. Sci. Eng. R: Rep. 86, 1 (2014).

[2]M. Castro, and R. Cuerno, Appl. Surf. Sci. 258, 4171 (2012).

[3]S. A. Norris, Phys. Rev. B 86, 235405 (2012).

[4]C. Madi, B. Davidovitch, H. B. George, S. A. Norris, M. Brenner, and M. J. Aziz, Phys. Rev. Lett. 101, 246102 (2008); ibid. 107, 049902 (2011).

[5]A. Moreno-Barrado, M. Castro, R. Gago, L. Vázquez, J. Muñoz-García, A. Redondo-Cubero, and R. Cuerno, Phys. Rev. B 91, 155303 (2015).

[6]S. A. Norris, J. C. Perkinson, M. Mokhtarzadeh, E. Anzenberg, M. J. Aziz, and K. F. Ludwig, Sci. Rep. 7, 2016 (2017).

[7]Javier Muñoz-García, Rodolfo Cuerno, and Mario Castro, submitted (2018).