Nanostructure of Thin Films Grown by Deposition of Isotropically Distributed Gaseous Particles

R. Alvarez[1], P. Romero-Gomez[1], J. Gil-Rostra, J. Cotrino[1,2], F. Yubero[1], A. Palmero[1], A.R. Gonzalez-Elipe[1]

[1] Instituto de Ciencia de Materiales de Sevilla (CSIC-US)
[2] Departamento de Física Atómica, Molecular y Nuclear (US)

Film growth involves the incorporation of species injected or formed in the plasma phase. These species may arrive at the growing film surface with different velocity distribution functions, depending on the deposition conditions, thus conditioning the development of the film nanostructure and surface morphology due to non-local surface shadowing processes: particles may possess a specific directionality, or follow an isotropic velocity distribution function in the plasma phase [1]. These latter particles contribute to the film growth in many situations, including films grown by thermal evaporation, sputter deposition [2], chemical vapor deposition, laser ablation [3], etc. In this work, growth of nanostructured thin films by deposition of gaseous particles that follow an isotropic velocity distribution function is experimentally and theoretically studied. Due to the complexity and number of existing experimental variables, we restrain the analysis to conditions where the sticking probability of the deposition particles can be considered unity and where the mobility of particles on the film surface is low (i.e., for depositions at low temperatures) [4]. Furthermore, due to their popularity and importance in science and technology, we experimentally focus on the magnetron sputtering deposition and the plasma enhanced chemical vapour deposition techniques, although our study is general and widely applicable to other situations. Amorphous thin films were deposited by magnetron sputtering at room temperature in two different experimental configurations. The obtained films were compared with others deposited by the plasma enhanced chemical vapour deposition technique in standard conditions, finding remarkable similarities in nanostructure and optical properties with films deposited in one of these configuration. Monte Carlo simulations indicate that similarities between these two nanostructures are caused by the incorporation and shadowing of particles that follow an isotropic velocity distribution function.

[1] R. Alvarez, P. Romero-Gomez, J. Gil-Rostra, J. Cotrino, F. Yubero, A. Palmero, A.R. Gonzalez-Elipe, Journal of Applied Physics 108(6), 064316 (2010)
[2] A. Palmero, H. Rudolph, F.H.P.M. Habraken, Appl. Phys. Lett. 89(21), 211501 (2006)
[3] R. Alvarez, A. Palmero, L. O. Prieto-Lopez, F. Yubero, J. Cotrino, W. de la Cruz, H. Rudolph, F.H.P.M. Habraken, A. R. Gonzalez-Elipe, Journal of Applied Physics 107(5), 054311 (2010)
[4] A. Palmero, H. Rudolph, F.H.P.M. Habraken, Thin Solid Films 515(2), 631 (2006)