Nanoporous gold thin films deposited by magnetron sputtering: Tailoring the porosity

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Nanoporous gold has attracted much attention in the science and technology for its high catalytic activity towards oxidation reactions. A key element for this functionality is the possibility of synthesizing gold thin films with large surface area with valleys that penetrate deep into the material. Although nanoporous gold has usually been synthesized by chemical dealloying, the possibility to use plasma-assisted deposition techniques would be desirable, not only because it might allow a better control on the surface and pore percolation features, but also from environmental and industrial points of view [4]. In this presentation we systematically analyze the microstructure of gold thin films deposited by magnetron sputtering at low temperature [2] and at oblique angles for a wide range of values of the substrate tilt angle, σ, and background pressure, p_{bg}, using advanced characterization techniques such as Field Emission Scanning Electron Microscopy (FESEM) and Grazing Incidence Small-Angle X-ray Scattering (GISAXS). We have also developed a Monte Carlo growth model [3], which accurately reproduces the experimental microstructures. As a result, we have found that the whole set of deposited films can be categorized through only four generic microstructures, based on which we have constructed a microstructure phase diagram [1]. Here, morphological features of the deposited films are linked to experimentally controllable quantities, such as σ and p_{bg}. Particular attention has been paid to the development of geometrical patterns in the bulk of the films as well as to the size and percolation depth of surface valleys, an aspect that has deserved little attention in previous studies in the literature for plasma-assisted depositions of thin films. Overall we have found that some of these microstructures possess large surface area with high connectivity among micro- and mesopores, features that make plasma-assisted techniques an alternative to wet chemistry techniques to synthesize nanoporous gold thin films.