

Tailoring the Porosity of Thin Films for Alternative Plasma Surface Engineering Applications

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Typical plasma surface engineered (PSE) applications focus on the fabrication of high-density thin films as required for surface protection, increased hardness or to provide special aesthetic appearances. This quest for compactness disregards an ample set of alternative applications where porosity and accessibility to fluids are essential. Yet, during the last two decades there have been much investigation on procedures based on the glazing angle impingement of ballistic atoms or moieties for the fabrication of open nanocolumnar thin films and high porosity. However, bringing these procedures to large scales remains challenging and current applications restrict to sensor, microfluidic and other small devices.

This presentation discusses a series of principles and possibilities to extend the scope of the preparation of porous thin films to the realm of plasma-based processes. At fundamental level this poses the need of relaxing the requirement of a pure ballistic deposition and the search for new deposition geometries. From an applied perspective, alternative approaches should consider the compatibility with the large area fabrication of coatings, as required for the development of electrochromic films, electrodes and catalysts for electrolyzers and fuel cells, membranes or similar systems. In these devices, rather than a structuration in the form of nano-sculptural thin films, key requirements are a high and well controlled porosity enabling the accessibility/release of reactants and products and the compatibility of the active coating with non-planar supports such as mesh, grids or similar structures.

Besides describing some basic mechanisms accounting for the micro- and nano-structuring of thin films prepared by plasma and magnetron sputtering deposition at oblique angles (OAD), it will be discussed the impact in the porosity of the layers of variables such as the surface state of the supports, the energy of impinging species or the use of scaffolds for the control of thin film microstructure.

The possibilities offered by the commented principles for the set up of alternatives PSE methodologies will be illustrated with real examples showing that the performance of devices incorporating OAD layers may efficiently compete with that provided by classical fabrication procedures using powders and other wet chemical methods.

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