Plasma processing of aerogel-like conformal coatings for photonic applications

Angel Barranco, Gloria P. Martínez, Jose Obrero, Lidia Contreras, Francisco J. Aparicio, Juan R. Sánchez-Valencia, Ana Borrás
Nanotechnology on Surfaces and Plasma Laboratory. Materials Science Institute of Seville (CSIC-US) c/Américo Vespucio 49, 41092, Sevilla, Spain.

Contact@E-mail angel.barranco@csic.es

Developing new fabrication methods for nanostructural control is crucial to synthesizing rationally designed materials with enhanced properties.[1] In such a context, plasma-activated deposition methods have evolved during the last decade from a focus on compact thin films towards the controlled deposition of nanoscale materials, including nanoporous layers, low dimensional carbon materials, and complex one-dimensional nanostructures.[2,3] Advantages of these vacuum-plasma methods mainly relay in their straightforward scalability, low deposition temperatures, compatibility with an ample variety of substrates, and high accuracy in the composition (including doping) of the deposited materials as well as the control of their morphological characteristic as microstructure, texture or alignment.[2,3] However, a critical bottleneck for applying such procedures for depositing nanoscale materials is the limited availability of volatile metalorganic and metal halide precursors. On the other hand, although there are many examples of the synthesis of porous oxides by plasma CVD,[4-5] the fabrication of ultraporous layers as aerogels has been mainly limited to wet-chemistry deposition methods.

The present work establishes the bases for a vacuum and plasma-supported methodology for fabricating metal-oxide nanostructured layers with controlled microstructure using solid metal precursors, phthalocyanines, and porphyrins.[6-8] Combining remote plasma synthesis and plasma processing of the growing films at low or room temperature,[9] we have been able to deposit conformal aerogel-like functional films of an ample variety of oxides. These films have direct applications in optics, photonics, and optoelectronics. The most advanced features of this method rely on its ample general character from the point of view of the material composition, crystallinity and microstructure, mild deposition and processing temperature and energy constrictions, and, finally, its straightforward compatibility with the direct deposition on processable substrates and device architectures. Examples of the fabrication of antireflection films, omniphobic surfaces, perovskite solar cell photoelectrodes, and thermochromic coating will be presented using this novel plasma-based approach that is directly scalable for industrial fabrication.

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