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Remote plasma assisted vacuum deposition: A plasma approach for the development of advanced organic and hybrid multifunctional materials

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Plasma polymerization represents a solvent-free, room-temperature, and competitive alternative for the development of organic nanometric films with surface chemical functionalities which are appealing for different fields such as biomedicine and electronics. Due to the inherent complexity of plasma polymerization processes, the synthesis of these materials typically addresses the incorporation of rather simple chemical functionalities present in a volatile precursor which is dosed into a plasma discharge. During the last years we have developed a "remote plasma assisted vacuum deposition (RPAVD)" technique intended to expand the scope of the plasma polymerization field. The process is conceived for the controlled incorporation, into plasma polymer films, of integer complex molecules of interest for functional applications. The RPAVD technique is based on the fine regulation of the interaction between a remote microwave plasma and the functional molecules sublimated in the afterglow region. To illustrate the possibilities and versatility of the technique we present results about photonic plasma nanocomposites hosting different organic dyes, such as perylenes, xanthenes, and flavonols; as well as their integration as active media in photonic structures (ring resonators, and photonic crystals). The optical properties of the films (light absorption, refractive index luminescence, optical sensor response, etc.) can be tailored and optimized thanks to the accurate control that the technique provides over the aggregation state of the dye within the plasma polymer matrix. We also show the advantageous use of co-polymerization processes to control the chemical and optical properties of the plasma polymer matrix. In the present communication, we pay especial attention to recent results about the development of luminescent photonic sensors and laser gain nanomaterials. Ongoing studies about the synthesis of bactericide, dielectric and nanostructured optoelectronic materials will be also presented. Finally, we discuss the synthesis of hybrid and heterostructure nanomaterials by combining the sublimation of metalorganic molecules and remote plasma techniques.

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