Luminescent plasma nanocomposites for the fabrication of photonic sensing devices

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Dye molecules embedded in different matrices in the form of thin films are the basis of specific materials used for laser cavities, optical filters, optical gas sensors, etc. Usually, the synthesis of this type of thin films is intended by sol/gel and similar wet methods and the films use to have a thickness of several microns. These procedures present some drawbacks as, for example, the need of different steps for drying, annealing, etc. Other limitations come from the microstructure of the films (e.g., surface roughness), that may impose some restrictions when these materials have to be integrated in optical and photonic devices. On the other hand the vacuum deposition of dye molecules produce films formed by small light dispersing crystalline aggregates with very poor optical and mechanical properties.

In the present communication we discuss a new methodology based on the plasma polymerization of dye molecules that circumvent the above mentioned problems [1-3]. It permits a tailored synthesis of optically active nanometric thin films containing dye molecules which are active as fluorescence emitters (i.e., coloured and fluorescent films). The principle of this new procedure is the partial polymerization of dye molecules that are evaporated over a substrate while exposed to a remote Ar plasma. As a result of this process a polymeric thin film is produced in one step where some dye molecules keep intact their optical activity (although eventually, their optical response can be slightly modified by matrix effects). This methodology has been recently used for the deposition of novel plasma nanocomposites containing non-aggregated laser dyes to maximize the fluorescent emission of the materials [1, 2] and for the fabrication of optical NO_2 sensing nanocomposites [3].

To illustrate the possibilities of the technique we present here results for different fluorescent dye molecules, as perylene dyes, and several xanthene and oxazine derivative cationic dyes which are typically used as gain media in tuneable laser dyes. The luminescent, optical and sensing properties of these dye containing nanocomposites will be presented. These active optical layers are being developed for the fabrication of photonic sensor devices and optical filters (PHODYE Project) [4]. This is due to the full compatibility of the synthetic methodology with the present integrated microelectronic and optoelectronic technology.

References

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