OPTICALLY ACTIVE PLASMA POLYMERS AND NANOCOMPOSITES FOR THE FABRICATION OF PHOTONIC DEVICES

F.J. Aparicio, I. Blasczcyk, A. Barranco, A.R. González-Elipe
Instituto de Ciencia de Materiales de Sevilla CSIC-Universidad de Sevilla, c/Américo Vespucio s/n 41092 Sevilla Spain
angelbar@icmse.csic.es

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 inconvenients 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. Trying to circumvent these problems there have been some essays of preparation of dye thin films by sublimation techniques. However, the resulting films are formed by small crystalline aggregates whose size in-creases with time and that are easily removable from the substrates during they manipulation. Another limitation of evaporation or sublimation procedures is that the actual concentration of dye molecules and their aggregation at an atomic scale cannot be controlled. This feature is critical if the absorption/fluorescence activity is the envisaged property for the final application of the films.

In the present communication we discuss a new methodology based on the plasma polymerization of dye molecules that circumvent the above mentioned problems [1, 2]. It permits a tailored synthesis of optically active thin films containing dye molecules which are active as absorbent or 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 where some dye molecules keep intact their optical activity (although eventually, their optical response can be slightly modified by matrix effects. By comparison with conventional thin films containing dyes prepared by sol/gel and similar procedures, this new type of dye thin films are much thinner (for example some tenths of nms are enough to get similar extinction coefficients that several micron films prepared by wet routes), are very flat and permit a very easy control of the matrix effects that influence the optical response of the dye molecules. For example, this methodology has been recently used for the deposition of plasma nanocomposites containing non-aggregated laser dyes to maximize the fluorescent emission of the materials [2]. To our knowledge, this is the first time that such a type of polymerization process rendering optically active films has been successfully achieved.

To illustrate the possibilities of the technique we pre-sent here results for different dye molecules, as perylene dyes, the Ethyl red, a neutral azoic dye used as pH sensor, and several xanthene and oxazine derivative cationic dyes which are typically used as gain media in tuneable laser dyes.

These active optical layers are being studied for the fabrication of devices as photonic sensors and filters (Phodye) [3]. This is due to the fully compatibility of the synthetic methodology with the present integrated micro-electronic and optoelectronic technology. The possibilities for the fabrication of photonic devices integrating these active optical layers will also be discussed.

References

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[2] A. Barranco, P. Groening. Langmuir **22**, 6719 (2006).

[3] New photonic systems on a chip based on dyes for sensor applications scalable at wafer fabrication (PHODYE EU Project) http://phodye.icmse.csic.es

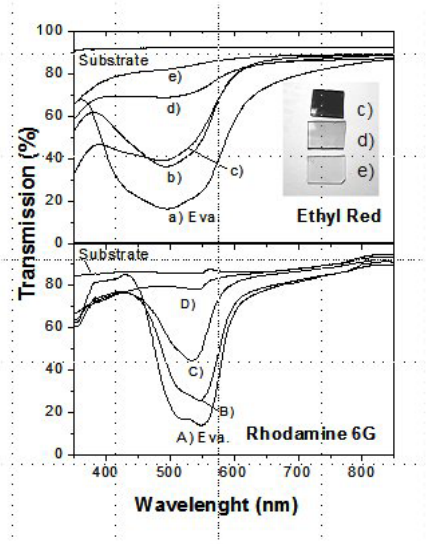

Fig.1 UV-vis spectra of several dye-containing plasma polymers