Control of the aggregation state of Rhodamine 6G dye molecules adsorbed in porous columnar GAPVD thin films

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Abstract

Rhodamine 6G (Rh6G) is a well characterized fluorescent dye molecule widely used for a large variety of applications.[1] For the majority of them, the dye molecule has to be incorporated as guest into a solid host material. This feature has fostered the development of many new synthetic and processing methods[2-4]. The main interest of these composite materials relies on the high fluorescence emission of the dye molecule in the solid material. The luminescent emission is associated with the agglomeration state of the dye and can be modified by the interaction with the solid matrix. Thus, previous studies on the fluorescence behaviour of Rh6G molecules incorporated into host matrices show that they can appear in the form of isolated molecules or higher aggregates. Such aggregates are the so-called non fluorescent H dimer and the fluorescent J dimers. These different type of aggregates are characterized by well defined absorption/emission frequencies and fluorescence yields.[5]

In the present work, Rh6G dye molecules have been incorporated into transparent and porous thin films of different oxides prepared by evaporation at glancing angles (GAPVD).[6] Hybrid composite films were prepared by immersion of the thin film into a solution of the dye at a given pH. It is found that the amount of Rh6G molecules incorporated into the film is directly dependent on the pH of the solution and can be accounted for by a model based on the point of zero charge (PZC) concepts originally developed for colloidal oxides.[7] At low pHs, the dye molecules are incorporated in the film as monomers and dimers or higher aggregates are formed as the pH increases. Depending on the actual preparation and treatment conditions, they also exhibit high relative fluorescence efficiency. The thermal stability of the composite films has been also investigated by characterizing their optical behaviour after heating in an Ar atmosphere at increasing temperatures up to 275 ºC. Heating induces a progressive loss of active dye molecules, a change in their agglomeration state and an increment in their relative fluorescence efficiency. The obtained luminescent hybrid composite thin films do not disperse the light and therefore can be used as optically active layers in optical structures or photonic devices.

References:

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Figures:

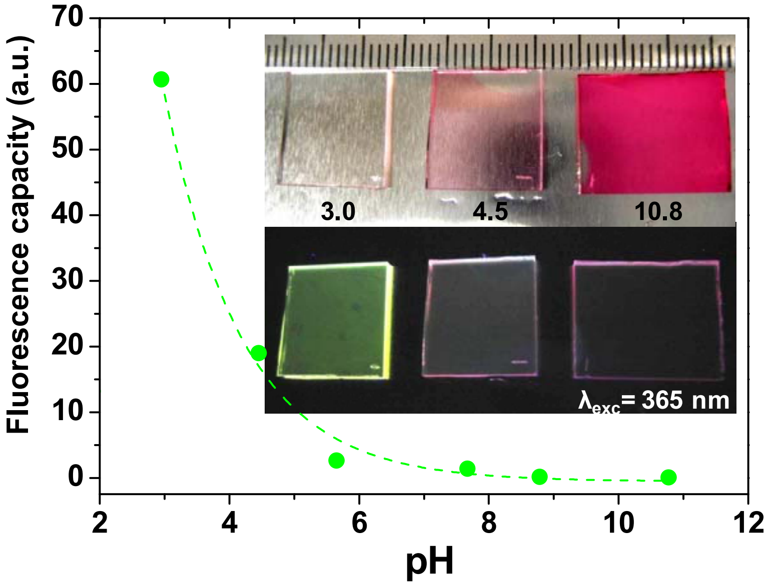

Figure. Representation of the fluorescence capacity as a function of the pH used for preparing the films. The inset shows images taken for actual films prepared at the indicated pHs that are being illuminated with an halogen lamp (top) and with a low energy fluorescent lamp (λ=365 nm) (bottom)