QUANTUM DOTS/POLYMER-NANOCOMPOSITES FOR LUMINESCENT OPTICAL FIBER PROBES

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The remote detection and monitoring of biochemical parameters have an increasing importance for a wide range of applications and industries. The combination of integrated optics and optical fiber technologies with luminescence based sensors, has successfully addressed the trend to miniaturization and demand for increasing sensibility and selectivity standards, particularly in environmental and biomedical applications. Some examples are already commercially available (e.g. oxygen and pH sensors). However, these sensors still show some limitations. The leaching and photo-bleaching of the sensing dyes are the most common problems. Furthermore, the majority of the luminescence based sensors show a strong dependence between temperature and luminescence intensity as well as the excited state lifetimes. The introduction of luminescent semiconductor nanocrystals (quantum dots: QDs) as sensing probes, can potentially solve some of these limitations [1,2].

QDs show improved properties when compared to conventional organic dyes, such as: narrow emission, broad absorption bands, high quantum yields, increased photostability and the ability to tune their properties by changing the nanocrystals size and/or composition. Colloidal suspensions of QDs can be prepared with a variety of emission wavelengths (from 350 to 2000 nm), and can be immobilized in a variety of matrices. The immobilization of QDs in polymeric matrices is particularly interesting, namely because the optical behavior of the final nanocomposites seems to depend on the type of polymer used. For example, we have shown that highly luminescent nanocomposites can be obtained with QDs immobilized in poly(butyl acrylate) (PBA) [3].

Here we wish to report our preliminary results on the use of CdSe/ZnS QDs-PBA nanocomposites as luminescent sensors in optical fiber sensing systems. Organically capped core/shell CdSe/ZnS QDs were first prepared using chemical reactions in high boiling point and coordinating solvents. These QDs were then used as the starting materials to produce QDs-PBA nanocomposites by *in situ* miniemulsion polymerization of butylacrylate.[3] Fiber probes were prepared using silica optical fibers with core/cladding diameters of 550/600 μm respectively. The fiber tips were slowly dipped in 50% HF prior to coating. By this method the cladding was removed and tapered probes were obtained with increased excitation/collection efficiency. The nanocomposites were then attached at the surface of the fiber tapers by dip/coating using a latex suspension, and then followed by drying with an air flow.

Using the setup in Figure 1, the coated fibers were excited with a blue laser diode (473 nm) and the luminescence response was recorded using a CCD spectrometer. It was observed that the fibers were uniformly coated with a polymer film displaying strong luminescence. The behavior of the luminescent probes was then tested under different working conditions. Here preliminary results will be shown demonstrating the suitability of the nanocomposite to be used as a self-referenced temperature fiber probe (Figure 2). When used in combination with other sensitive dyes these fiber probes will enable temperature independent measurement of a diversity of analytes. Results showing the influence of pH in the luminescent signals will also be presented.

In addition, we will show that the nanocomposite materials after acid hydrolysis can be enriched in functional groups at the surfaces, thus providing potential for biofunctionalization procedures. This is an important feature since it can open the way to the detection of a wide variety of analytes at the tip of an optical fiber, including biological material, enabling the fabrication of advanced analytical tools.

References:

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[4] A. C. C. Esteves, A. Barros-Timmons, T. Monteiro and T. Trindade, Journal of Nanoscience and Nanotechnology, **5,** (2005) 766-771.

Figures:

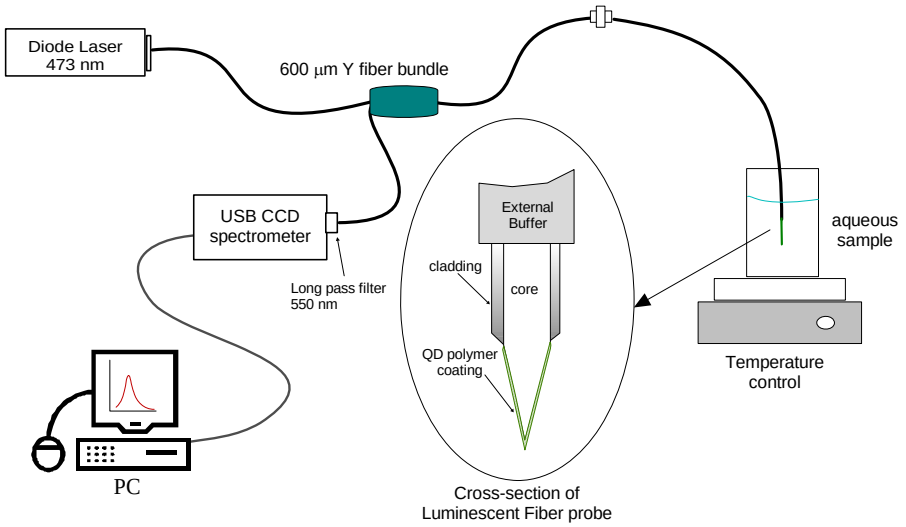

Figure 1: Experimental set-up for characterization of the luminescent fiber probes.

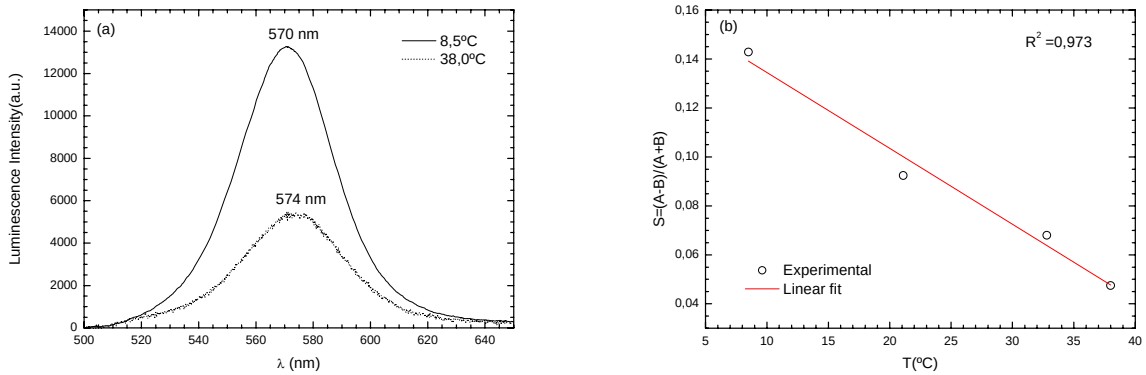

Figure 2: (a) Spectral response to temperature of immobilized QD. As temperature increases luminescence is quenched and emission peak is red shifted (b) Application of a ratiometric scheme allows obtaining a self-referenced output with linear dependence on temperature.

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