

## Optical fiber pH sensor formed by Neutral Red and Poly(acrylic acid) nanostructured films.

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In this article we propose a new approach to the construction of a fiber optic pH sensor based on the absorbance changes of the well known Neutral Red (NR) colorimetric pH indicator [1] attached via the Layer-by-Layer (LbL) method to the polymer poly(acrylic acid) (PAA), see Figure 1. Several methods have been studied in literature to add this pH sensitive molecule (NR) to the substrate [2-3]. Here we propose the utilization of Layer-by-Layer (LbL) deposition technique, a widely studied method by our group and already used in some of our previous works [3-4]. The LbL method has attracted a great interest in the past few years and it is very suitable for our purpose due to the advantages associated with the construction of nanosized and well organized multilayer films [5]

The structure of this device is formed by the co-deposition of NR as the cationic monolayer and PAA as the anionic monolayer deposited along a bare optical fiber core section as is represented in the sensor detail of Figure 2. This bilayer structure is grown onto the optical fiber core using the LbL technique up to 15 bilayers. The construction process is monitored using the setup showed in Figure 2 by measuring the absorbance changes of the reflected optical power arrived to the spectrometer after the double transmission path across the sensitive section of the fiber. The excitation used in all measurements is a broad band white light source from 400 to 800 nm. The curves in Figure 3 represent the absorbance changes per bilayer of the [NR/PAA]<sub>15</sub> structure build up process. The absorbance increases almost linearly with the number of bilayers deposited as is shown in Figure 3. The growth in absorbance also occurs in the region associated to the absorbance spectrum of the NR molecule which also indicates the correct deposition of the NR small molecule. This new approach, the construction of a structure formed by a small molecule (NR) and a large chain polymer (PAA) by the LbL method, is very promising because it opens a new path to be investigated with the LbL technique and instead of using polycationic and polyanionic species (big molecules) that form a polymeric matrix which embeds the sensing indicator (small molecules) it is also possible to use a wide variety of these small molecules as monolayers of the LbL process, therefore eliminating the polymeric matrix [6].

Additionally, Figure 4 shows the changes in absorbance of the probe at 520 nm when the probe was immersed in pH 3.0 and pH 7.0 solutions alternatively. The response of the NR/PAA coatings was very fast (around a few seconds) when pH was increased from 3.0 to 7.0 while the response was slower (about 30 seconds) when the pH was decreased from 7.0 to 3.0. In addition it has been probed that this structure is suitable to be used for measuring pH in the neutral range with high precision, fast response times and repetitive signals.

## References:

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## Figures:

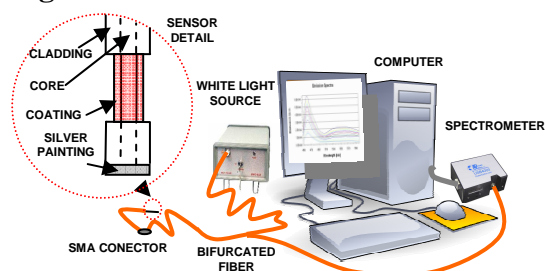


Figure 1. Experimental setup for absorbance measurement.

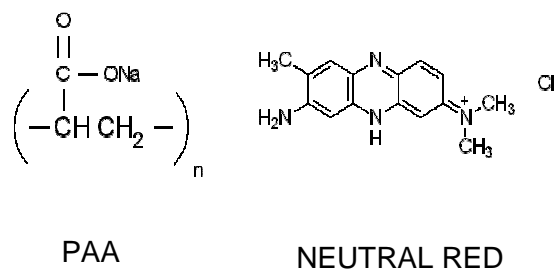


Figure 2. Molecular structure of the chemicals used in this work.

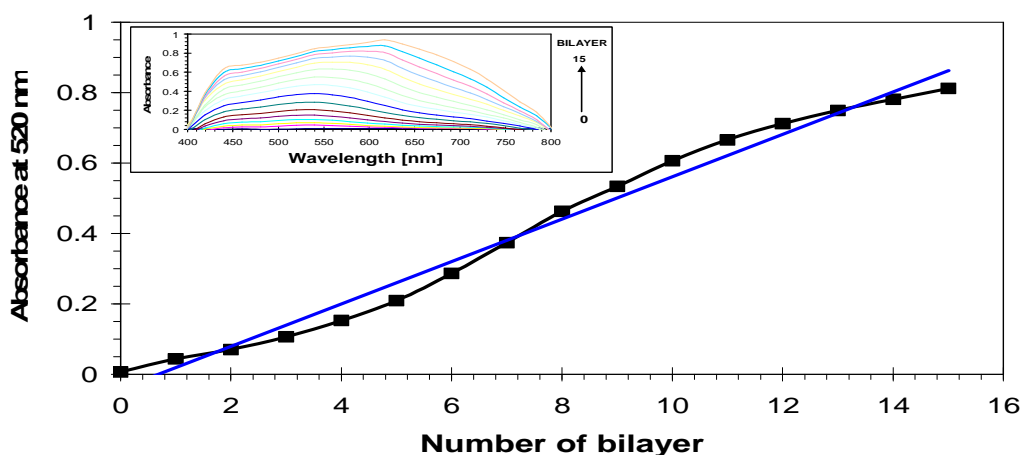


Figure 3. Absorbance at 520nm against the number of NR/PAA bilayers. Inset: Absorption spectra when the number of NR/PAA bilayers is increased.

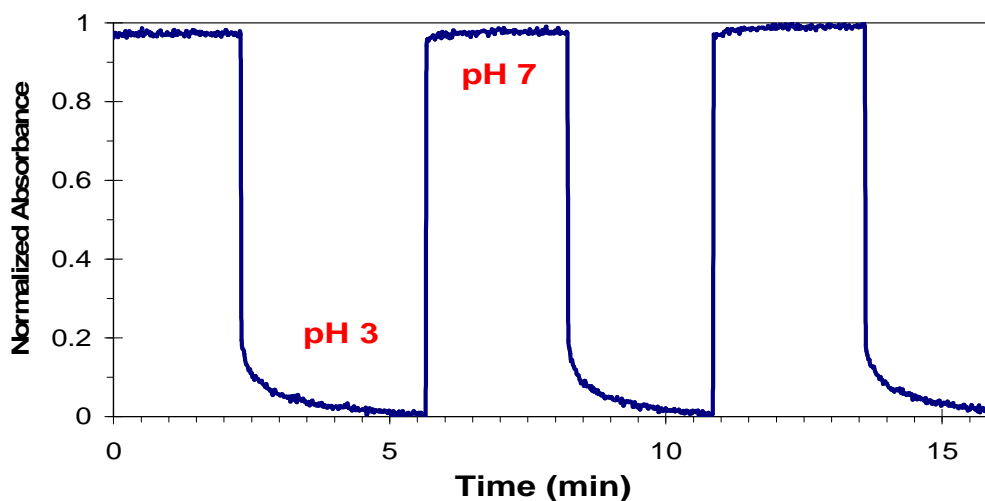


Figure 4. Normalized absorbance when the coating was alternately immersed in pH 7.0 and pH 3.0 solutions.