Study on organic light emitting diodes based on self-assembled structures of poly(phenylene vinylene((PPV) and poly(acrylic acid) (PAA) using a fiber optic interferometric technique

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The potential applications of organic materials in the optoelectronic industry have shaken the research world in the past ten years. Since the first Organic Light Emitting Diode (OLED) was discovered in 1990 [1], this technology has created an enormous interest in a lot of research groups and enterprises all over the world. Several companies have already fabricated prototypes based on this type of technology using techniques as spin-coating and inkjet printing [2]. But there are still some problems in the display fabrication and the lifetimes and efficiencies of the devices. In this respect, a very precise control of the thickness of the layers and properly designed multistack structures should be used in order to achieve competitive performance parameters. Referring to this, the Electrostatic Self-Assembly (ESA) technique allows the creation of multilayer structures via the alternative immersion of a substrate into solutions of oppositely charged materials. A high number of different materials can be assembled using this technique onto a wide variety of substrates, almost independently of their size or shape, allowing the fabrication of multiple devices as organic solar cells, antireflective coatings, and fiber optic sensors [3][4]. This characteristic makes the ESA technique especially interesting for devices based on thin films, particularly for flat display technology. The resulting composite material properties strongly depend on the fabrication parameters leaving to the designer a variety of parameters to be tuned in order to obtain the desired properties [5]. More specifically, the influence of the pH value of the polyelectrolyte solutions has been one of the parameters which has been studied in order to tune the assembly process.

For the assemblies, a water soluble tetrahydrothiophene precursor of poly(p-phenylene vinylene) (PPV), one of the most employed emissive polymers, was used as polycation and poly (acrylic acid) (PAA) was chosen as polyanion. Positive and negative charged layers are alternatively adsorbed in a repetitive fashion to build up the active film. Multilayer structures consisting in a single block of several PPV/PAA layers have been built up onto a Indium Tin Oxide (ITO) coated glass substrate. After the thermal conversion of the PPV precursor, then Aluminum is thermally evaporated on the top of the polymeric layer. The resulting active film properties strongly depends on the fabrication process and by tuning some experimental parameters the performance of the devices could be dramatically affected.

In addition, a fiber optic interferometric technique is presented as an auxiliary tool to monitor the growing of the multilayer structure. In this technique a cleaved optical fiber is used as substrate. When layers are added to the self-assembled structure, a nano-Fabry-Perot interferometric cavity is being created onto the end-face of the optical fiber (Fig. 1). Therefore, studying the interference characteristics of the on-fiber assemblies, some parameters of the resultant film (thickness, roughness, etc) can be deducted. As conclusion, after tuning the parameters of fabrication, pH of the polymeric solutions, relatively high efficiencies for a single stack device with aluminum cathode can be achieved (Fig. 2).

References:

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Figures:

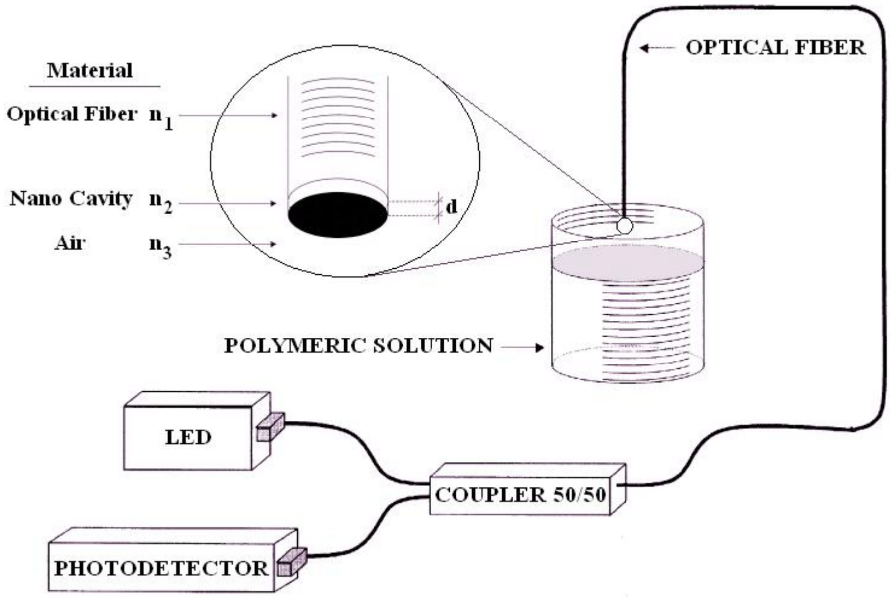

Figure1.- Experimental setup arranged to monitor the building up of the multilayer assemblies. The inset shows a scheme of the on-fiber Fabry-Perot nanocavity created.

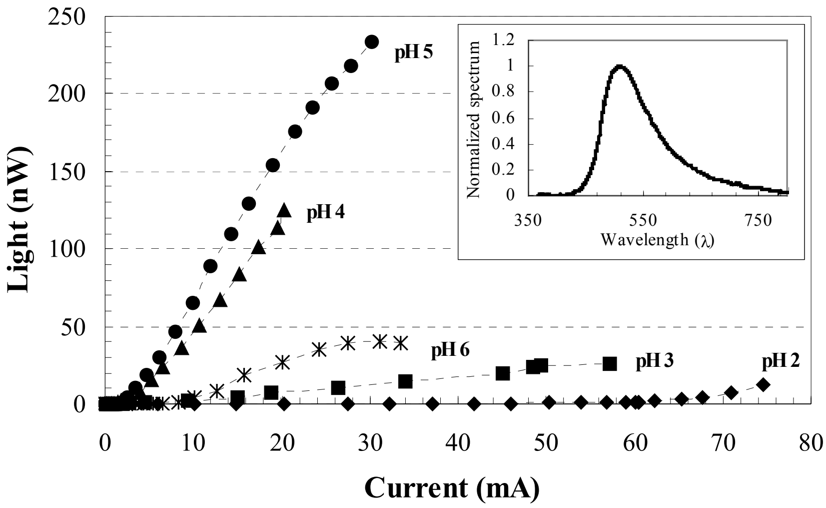

Figure 2.- Light vs. Current plot. The slope of the curves gives an idea of the efficiency of the device. Inset: Emission spectrum.