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Taking the Advantage of Electrostatic Interactions to Grow Langmuir-Blodgett Films Containing Multilayers of DPPG

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Abstract – DPPG multilayer LB films were produced by transferring the DPPG Langmuir monolayers from the water subphase containing PAH. The UV-Vis showed that the multilayer LB films can be grown in a controlled way and The FTIR revealed that the interaction between the groups NH_3^+ (PAH) and PO_4^- (DPPG) is the driven force that allows the growth of these films. Despite the interaction with PAH, the cyclic voltammetry showed that the DPPG keeps its biological activity in the LB films. Finally, sensing units formed by LB and LbL films of DPPG were applied in the methylene blue (MB) detection using impedance spectroscopy.

The use of phospholipids as mimetic systems for studies involving cell membrane is a well known approach. In this context, the Langmuir and Langmuir-Blodgett (LB) are among the main techniques applied to produce single layers of phospholipids structurally as mono or bilayers onto water subphase and solid substrate. However, the difficult to produce multilayer LB films of phospholipids restricts the application of this technique depending on the sensitive of the experimental analysis to be carried out. Here, an alternative approach is used to produce LB films containing multilayers of the negative phospholipid DPPG. Inspired in the electrostatic layer-by-layer (LbL) technique, DPPG multilayer LB films were produced by transferring the DPPG Langmuir monolayers from the water subphase containing low concentrations of the cationic polyelectrolyte PAH. The ultraviolet-visible (UV-Vis) absorption spectroscopy showed in figure 1 that the multilayer LB films can be grown in a controlled way in terms of thickness at nanometer scale. The Fourier transform infrared (FTIR) absorption revealed that the interaction between the groups NH_3^+ (PAH) and PO_4^- (DPPG) is the driven force that allows the growth of these LB films, as shown in figure 2. Besides, In a comparison with LbL films, the cyclic voltammetry showed that DPPG and PAH are more packed when forming the LB films. This work is close related to the distinct molecular architecture of the films since the DPPG is forming monolayers in the LB films and multilamellar vesicles in the LbL films. Despite the interaction with PAH, the cyclic voltammetry also showed that the DPPG keeps its biological activity in the LB films, which is a key factor since this makes DPPG a suitable material in sensing applications. Therefore, the multilayer LB films were deposited onto Pt interdigitated electrodes forming sensing units, which were applied in the detection of a phenothiazine compound (methylene blue – MB) using impedance spectroscopy. The performance of the DPPG in single and multilayer LB films was compared to sensing unities composed by DPPG in single and multilayer LbL films evidencing the importance of both thickness and molecular architecture of the thin films. As found in a previous work for LbL films [1], the high sensitivity reached by these sensing units is intimately related to changes in the morphology of the film as evidenced by micro-Raman technique. Finally, the interaction between MB and the (DPPG+PAH) LB films was complemented by π-A isotherms and surface-enhanced resonance Raman scattering (SERRS).

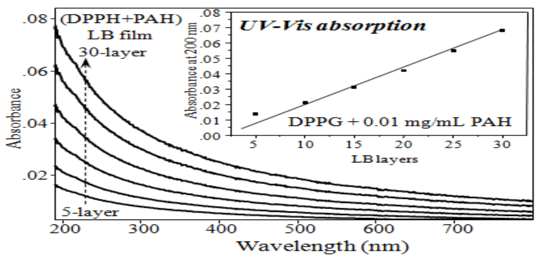

Figure 1. UV-vis absorption spectra for LB film of (DPPG+PAH) containing different numbers of layers.

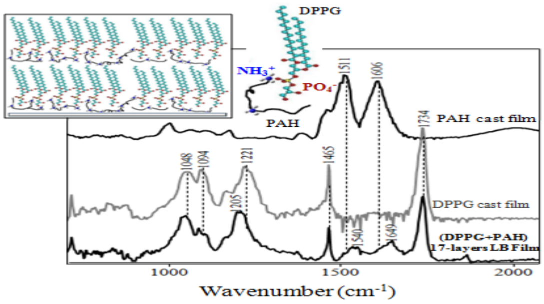

Figure 2. FTIR absorption spectra for 17-layer LB film of (DPPG+PAH), DPPG cast film and PAH cast film.

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References

[1] P. H. B. Aoki, D. Volpati, A. Riul, Jr., W. Caetano and C. J. L. Constantino, Langmuir 25 (2009) 2331-2338.