Organized molecular thin films for technological and biomimetic applications

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Organized molecular films can be obtained with several techniques, such as Langmuir, Langmuir-Blodgett and Langmuir-Schaeffer. The obtained films are of nanometric dimension and can be monolayers or multilayers. The applications of these films depend on the characteristics of the constituent molecules, but also on their organization and molecular orientation. Furthermore, the nanometric size of the films, at least in their thickness, allows them to be integrated in micro and nanodevices. Some of the applications are in sensing, electronics, optics, MEMS and NEMS, photovoltaics, artificial photosynthesis, cancer dynamic phototherapy, pharmaceutics, biomembranes and biomimetic studies.

In the Laboratory of Electrochemistry, Interfaces and Nanometric Films (LEIPN) we are currently involved in: a) thin films of redox molecules, with or without a biological matrix supporting these molecules [1-3], b) studies of lipid biomembranes and the influence of proteins or bactericides on their constitution and integrity [4-5], and c) studies of the tear film, and more precisely of the lipid layer of the tear film [6].

In this presentation, the techniques used and the principal results of our studies will be presented. The molecular thin films are obtained basically with the Langmuir and Langmuir-Blodgett techniques. Also, the formation of lipid liposomes and their spreading forming planar bilayers is sometimes used. The Langmuir film formation can be monitored using the surface pressure and the surface potential, plotting these magnitudes versus the molecular area. The Langmuir films can be observed with an optical microscope, the Brewster Angle Microscope (BAM) even the molecular thickness of the film. The influence of inserted molecules in the matrix film can be detected analyzing the surface pressure-area isotherms and the BAM images. The Langmuir films can be transferred to a solid substrate using the Langmuir-Blodgett (LB) technique. These LB films can be characterized using Scanning Probe Microscopies, as Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Force Spectroscopy (FS) and Friction Force Microscopy (FFM). The presence of redox groups in the molecules allows characterising their electrochemical behaviour using cyclic voltammetry and conducting substrates, as ITO, glassy carbon or metals. The electrochemical behaviour of the films can be completed with Electrochemical Impedance Spectroscopy (EIS). Additionally, spectroscopic techniques and contact angle measurements are available.

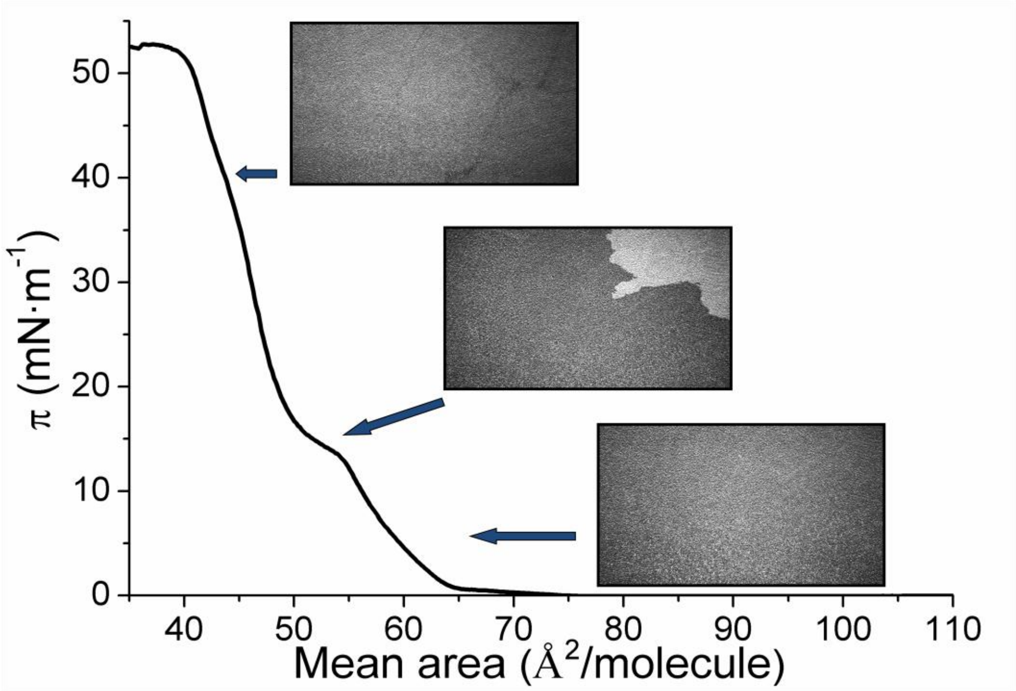

Figure 1. π-A isotherm and BAM images of a MGDG:UQ 10:1 mixture monolayer at 21ºC.

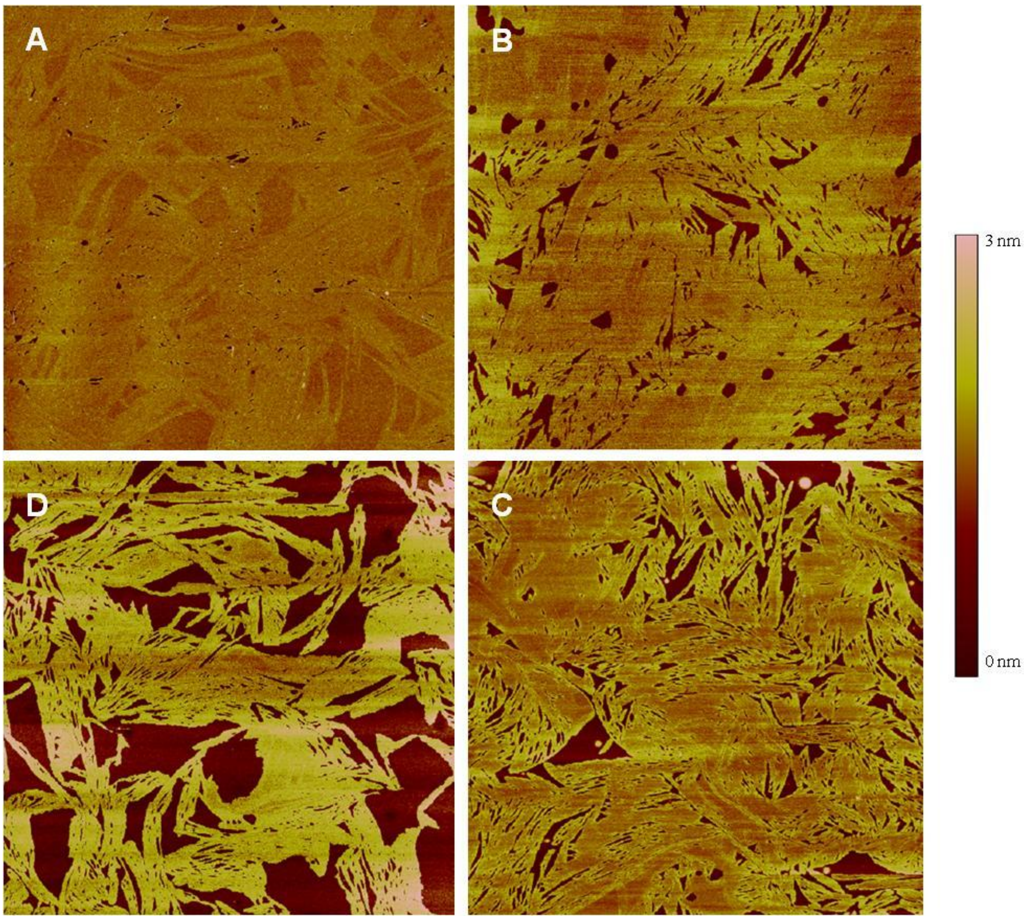

Figure 2. AFM images (10 μm x 10 μm) of LB films transferred on mica at 21ºC and π = 6 $mN{\cdot}m^{-1}$ for A) pure MGDG, B) MGDG:UQ 20:1, C) MGDG:UQ 10:1, D) MGDG:UQ 5:1.

References

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[6] Several TFM conducted at the FOOT (Facultad d'Òptica i Optometria de Terrassa), supervised by E. Guaus and J. Torrent-Burgués.