NOVEL IMAGING DEVICES FOR OPTICAL AND MECHANICAL CHARACTERIZATION OF SUPPORTED LIPID BILAYERS AT THE NANOSCALE

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Abstract

We present an overview of two scientific instrumentation developments introduced by the Applied Nano-Optics Laboratory of the International Iberian Nanotechnology Laboratory for the advancement of supported lipid bilayer investigations at the nanoscale.

First, we introduce the concept of thin film optical anisotropy imaging as determined by spectroscopic imaging ellipsometry.[1] Following theoretical considerations derived from an optical biaxial thin film model for a supported lipid bilayer on silicon in an aqueous environment, we obtain optimal angle of incidence and wavelength parameter settings for extracting thin film anisotropy. Subsequently, we detail two experimental set-ups for spectroscopic imaging ellipsometry and compare their respective performance for spatially resolved thin film anisotropy measurements. It is demonstrated that sample illumination light power at the sample plane is critical to improve accuracy of thin film anisotropy determination at the solid-liquid interface.

Our second instrumentation development for the analysis of lipid structures is placed within the realm of combined microscopy.[2] Namely, we present a new type of combined microscopy based on Quantitative Imaging Atomic Force Microscopy (QI™-AFM), a type of force-volume imaging at high speeds in liquid media, and differential spinning disk (DSD) fluorescence optical sectioning microscopy. In particular, we discuss two types of system specific noise affecting AFM cantilever motion induced by the mechanical motion of the spinning disk and fluorescence excitation light respectively. Solutions to reduce the contribution of these noise sources are detailed. We conclude by demonstrating our new combined microscopy platform for the analysis of supported lipid bilayers labelled with a carbocyanine dye on mica (Figure 1) and by discussing how this new microscopy platform can provide new capabilities in the study of live cell signaling mechanisms.

References

[1] P. De Beule and A. Miranda, “Anisotropy Imaging of Supported Lipid Bilayers via Spectroscopic Imaging Ellipsometry,” in Optics in the Life Sciences, OSA Technical Digest (online) (Optical Society of America, 2015), paper JT3A.42.

[2] A. Miranda, M. Martins, and P. A. A. De Beule, “Simultaneous differential spinning disk fluorescence optical sectioning microscopy and nanomechanical mapping atomic force microscopy,” Review of Scientific Instruments, **86**, 9 (2015) 093705.

Figures

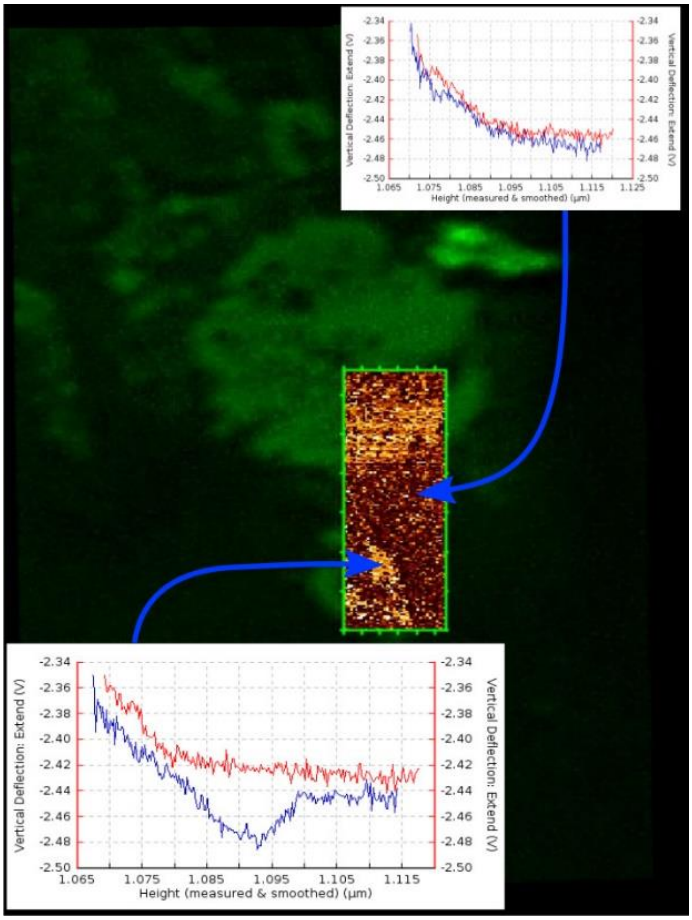

Figure 1: DOPC/DOPS lipid structure labelled with DiI. The green background image represents an optically sectioned fluorescence intensity registered with an adhesion image derived from the analysis of pixel resolved force-curves. Example force curves of the mica background (top) and the DOPC/DOPS lipid structure (bottom) are shown, whereby the red and blue curve represent extend and retraction force curves respectively.