Application Note # 109

Langmuir-Blodgett Film Characterization in Air Using MP-SPR

Multi-Parametric Surface Plasmon Resonance (MP-SPR) was utilized to characterize Langmuir-Blodgett (LB) deposited mono- and multilayers of stearic acid. Thickness of one LB layer was determined to be 2.45 nm.

Introduction

The ability to assemble ordered molecular films with tailored functionality over macroscopic lateral dimensions provides exciting and unique opportunities in many practical and commercial applications. Sensors, detectors, displays and electronic circuit components are just a few examples.

This well-known technique is referred to as Langmuir-Blodgett (LB) deposition, where films of functional molecules, nanoparticles, nanowires or microparticles are spread at the air-water interface, compressed and transferred to a solid substrate.

SPR phenomenon is based on free electrons resonating at a metal surface, which are excited with light. There is an absorption maximum as a function of the angle of the incident light, and the SPR phenomenon is highly dependent on the dielectric constant near the metal surface. Any changes near the surface, such as deposition of new layer, change the angle of the absorption maximum. Due to the MP-SPR unique optical setup instrument can be utilized for determining not only affinity and kinetic of the interaction but also layer properties like thickness and refractive index.

Materials and Methods

The gold-coated glass slides used in the SPR measurements were cleaned by ammonia hydrogen peroxide mixture which is an excellent cleaning method for gold sensor slides. Sensor slides were immersed in a boiling mixture of 1 part 30% NH_4OH, 1 part 30% H_2O_2 and 5 part of water for ten minutes, flushed thoroughly with ion exchanged water and blown dry with nitrogen.

Monolayers and multilayers of Cadmium Stearate (SACd, (C17 H35 COO)2 Cd) were deposited *ex situ* via the LB technique (KSV Minitrough System) on cleaned gold slides, as illustrated in Figure 1. Full SPR curves were measured after depositing one, three and five layers of SACd on separate gold slides.

Details of the deposition method can be found from the full journal publication [1].

Results and Discussion

Figure 2 illustrates SPR intensity versus angle curves for the clean gold surface, and for surfaces with one, three and five deposited layers of SACd. There are some differences in the absolute minimum value in the SPR curves between different samples. This difference stems from the use of separate gold slides, and does not affect the validity of the measurement.

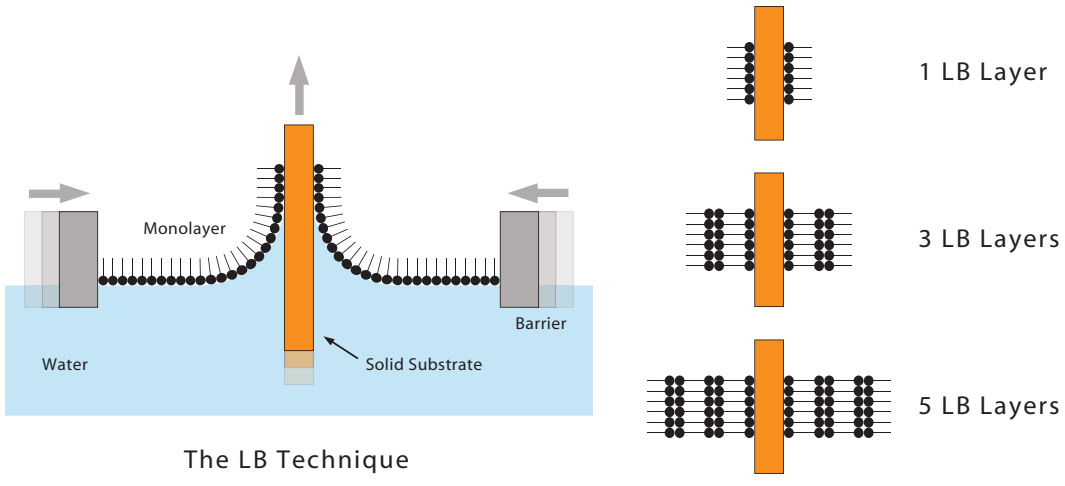

Figure 1. The Langmuir-Blodgett (LB) technique, used to deposit single and multiple layers of stearic acid on a gold sensor slide.

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Fitting the experimental data (solid curves, Fig.2) allows determination of the layer thickness of the deposited LB layers. Figure 3 shows that thickness increases linearly with layer number, as expected for this system. Meanwhile, the slope of the thickness vs. layer number plot is 2.45 nm/deposited layer, which is in very good agreement with literature [2].

Conclusions

Langmuir-Blodgett enables deposition of wide range of materials and it´s combined excellently with MP-SPR characterization method which works with virtually any material. MP-SPR is precise tool to determine nanolayer thicknesses based on whole SPR curves as shown with stearic acid layers characterization. LB and MP-SPR can be utilized in several application areas like in the fields of nanotechnology and functional materials.

MP-SPR enables measurements with *in situ* or *ex situ* deposited layers which makes it versatile tool for characterization. The unique MP-SPR measurement principle allows not only interaction and thickness calculations of deposited layer but also layer refractive index (RI) can be determined. Thickness and RI can be determined without prior knowledge of either one of them – more information can be found from the BioNavis application note #128.

References:

[1] Liang, et al., Sensors and Actuators B: Chemical 2010, 149(1), 212-220

[2] Lee S. et.al. Langmuir 8 (1992) 1243-1246

Recommended instrumentation for reference assay experiments
SPR Navi™ 200, 210A or 220A with additional wavelength (-L)
Sensor surfaces: Au, other metal or inorganic coating
Software: SPR Navi™ Control, SPR Navi™ Data Viewer and SPR Navi™ LayerSolver

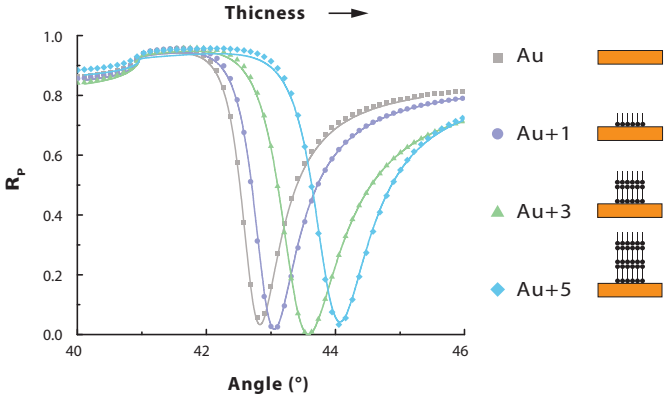

Figure 2. Complete measured (dots) and fitted (lines) SPR curves from left to right clean gold surface, 1, 3, and 5 SACd LB layers.

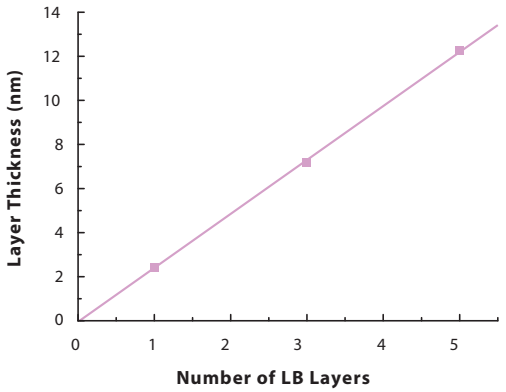

Figure 3. Modelled layer thickness as a function of layer number for SACd LB layers. The solid line is a linear regression fit to the data (R=0.99988).

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