Langmuir-Blodgett film characterization in air using surface plasmon resonance

Application Note #109

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. Compared to other organic thin film deposition techniques, such as thermal evaporation, sputtering, electrodeposition, molecular beam epitaxy, layer-by-layer or self-assembly, LB is much less limited by the molecular structure of the functional molecule. This means that it is often the only technique that can be used for bottom-up assembly in nanotechnology and functional materials applications. The aim of this note is to demonstrate that SPR-Navi from KSV Instruments Ltd. is ideal for the *ex situ* investigation in air of mono- and multilayer films of stearic acid deposited on a gold surface.

Experimental

The gold-coated glass slides used in the SPR measurements were cleaned by immersion in a boiling 1:1:5 NH_3OH:H_2O_2:H_2O for ten minutes, flushed thoroughly with ion exchanged water and blown dry with nitrogen. Monolayers and multilayers of Cadmium Stearate (SACd, $(C_{17}H_{35}COO)_2Cd$) were deposited via the LB technique (KSV Minitrough System 2) on cleaned gold slides, as illustrated in Figure 1. Complete SPR curves were measured after depositing one, three and five layers of SACd on separate gold slides.

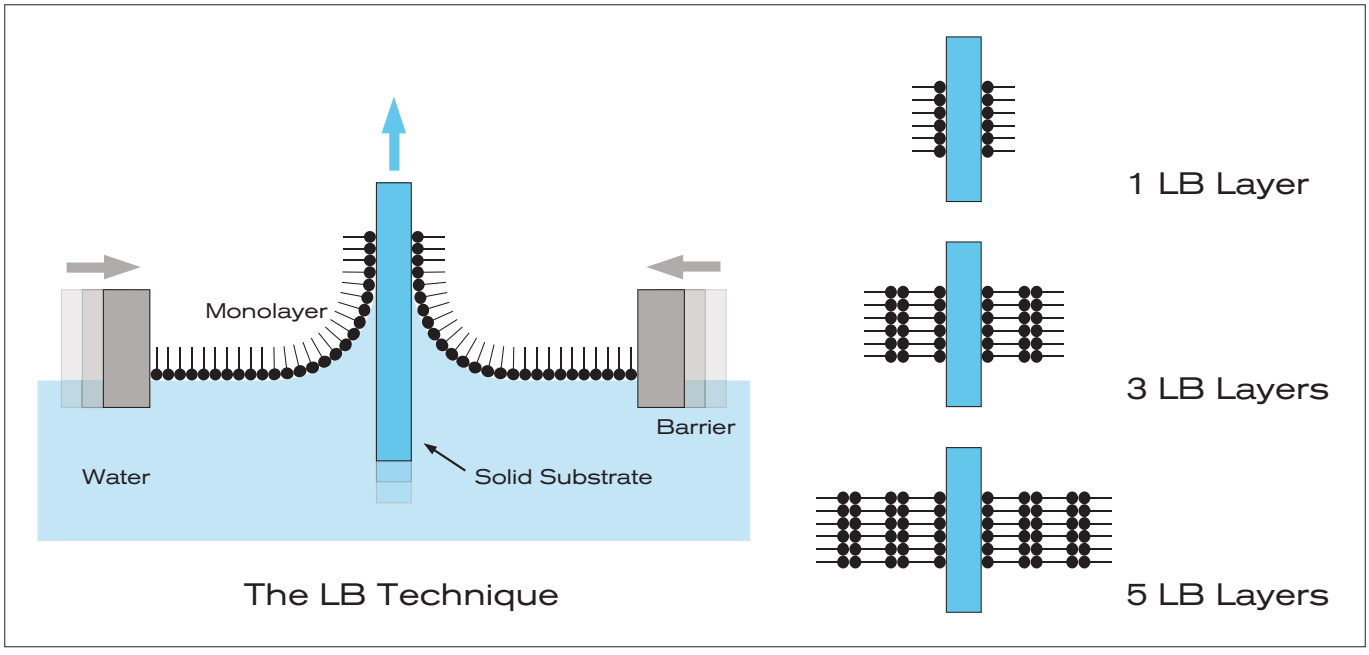

Figure 1. The Langmuir-Blodgett (LB) technique, used to deposit single and multiple layers of molecules on a solid substrate.

Results

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.

Fitting the experimental data with a theoretical model (solid curves, Figure 2) allows determination of the layer thickness of the deposited LB layers (WinSPALL Software, Wolfgang Knoll, MPI, Germany). 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.[1]

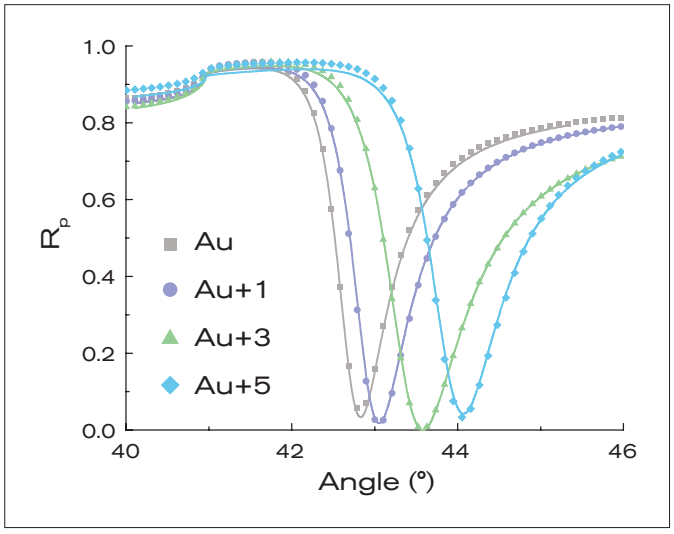

Figure 2. Complete measured (dots) and fitted (lines) SPR curves for clean gold surface, 1, 3, and 5 SACd LB layers.

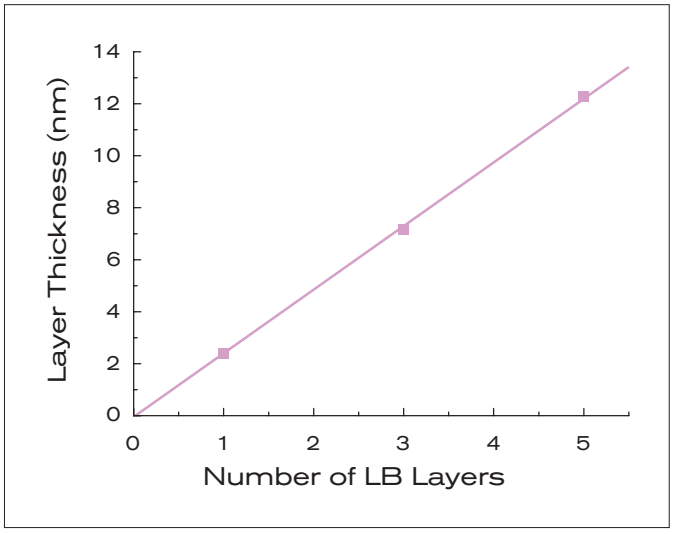

Figure 3. Modeled layer thickness as a function of layer number for SACd LB layers. The solid line is a linear regression fit to the data (R=0.99988).

[1] Lee, S. et. al. *Langmuir* 8 (1992) 1243-1246

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