Crystalline Growth of Rubrene Film Enhanced by Vertical Ordering in Cadmium Arachidate Multilayer Substrate

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Rubrene exhibits impressively high single-crystal field-effect mobility up to 20 $cm^2V^{-1}s^{-1}$. Unfortunately, high-quality crystalline rubrene films grown by vapor deposition are very difficult to come by, presumably limited by the co-presence of a myriad of rubreneadsorbate configurations and an unfavorable energetic barrier between gaseous and adsorbed rubrene molecule. Consequently, the hole mobility of rubrene thin-film transistors falls into a paltry range of 10^{-4} to 10^{-1} $cm^2V^{-1}s^{-1}$. Suffice it to say that the growth of highly crystalline rubrene thin films remains a major challenge.

We have shown that one needs to think beyond a surface modification scheme and employ a substrate exhibiting vertical profile in order to facilitate a crystalline growth of rubrene.[1] In that report, the Langmuir-Blodgett (LB) films of odd-number layers of cadmium arachidate (CdA) grown on SiO_2 were used as the substrates for growing rubrene films. These substrates are surface-terminated identically by the methyl group but exhibit the thickness-dependent morphology.The structures and morphology of rubrene and CdA films were extensively characterized by XRR, XRD, NEXAFS, and AFM. XRD data indicate that a highly crystalline CdA film indeed supports a better crystalline growth of rubrene. This observation is rationalized by an enhanced sidewall interaction between CdA islands and rubrene molecules with the strengthened interaction derived from a close dimensional match between the *a*-axis of rubrene lattice and the layer spacing of CdA multilayer. As a result, CdA island distribution is deemed critical in determining the efficacy of crystallinity enhancement. In this presentation, we shall report on the results obtained from extended studies of enhanced crystalline growth on LB multilayers prepared in both even- and odd-number layers as well as using different counter cations like magnesium to vary the island density in a systematic manner.

[1].C.-H. Wang, et al. Langmuir 2013, 29, 3957-3967.