MNSC

Pentacene Thin Film Growth on Gold and Silver: Substrate Effect on Molecule Orientation and Film Structure

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Introduction

Pentacene thin film structure of more than one monolayer on gold substrates is currently controversial: some authors postulate a flat-lying layer by layer growth [1, 2], while others declare a dewetting and island growth with an upright orientation of molecules [3]. In this paper, pentacene thin films from 5 nm to 150 nm thickness on gold and silver have been studied using angle-dependent near-edge X-ray absorption fine structure (NEXAFS) spectroscopy. We observe that pentacene forms a well-defined thin-film structure on silver substrates with the long molecule axis perpendicular to the substrate plane. In contrast for gold substrates, molecules tend to be flat-lying for all thickness.

	Tilting angle of PEN molecules	
Film thickness (nm)	**Au**	**Ag**
5	44	79
50	46	79
100	50 (45 on Au(111))	69 (70*)
150		71 (70.5*)

Figure 2. Summary of NEXAFS of PEN with different thickness on Au and Ag substrates

	Ref 1	Ref 2	Ref 3	Our Exp
Speed	0.5 – 3 A/ min	0.1 -1.3 A/min	60 A/min	18 – 42 A/min
Substrates Roughness	Atomic	Au(111) on mica (100 nm terraces)	Deposited Au(cr)	Deposited Au(cr), Ag, Au(111) on mica

Figure 3. Comparing of film growth speed and substrates roughness between references and our exps

Experimental Results

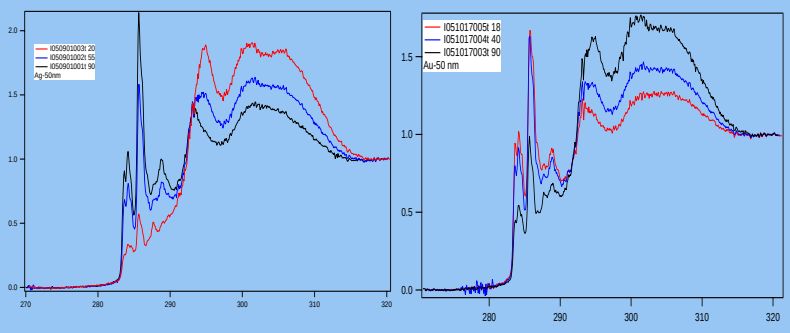

Figure 1. NEXAFS spectra of 50 nm PEN on Au (left) and Ag (right). On Au: I_{π^*} increases as incident angle decreases – flat configuration; On Ag: the reverse – perpendicular configuration

Conclusion

Pentacene thin films show completely different molecule orientations and film structures on Au and Ag substrates. Strong interaction between substrates and molecules will lead to a flat-lying monolayer. But for multilayer films, the thin-film or crystal structures, with molecules nearly perpendicular to the substrates, are more favorable. How this competition between these two driven forces lead to different thin film structures is still unclear.

Reference

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