Wetting on Nano-Patterned Surfaces

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& (Experiments Carried out at NSLS, Beam Line X22B)

Research Summary

• We present here x-ray studies of wetting films on geometrically patterned silicon substrates.
• These “nano-patterned” substrates are characterized with AFM, SEM, & TEM which can be directly compared with x-ray results.
• We demonstrate the strong influence on the structure of wetting layer by the topography of the substrate; and the filling of the “nano-pores.”

Research Motivation

• Fundamental physics associated with wetting on nano-scales is of wide current interest [1].
• Wetting on nano-patterned surfaces is a crossover between wetting and capillary condensation.
• Depends on both molecular interactions and surface topology.
• Understanding of the phenomena is crucial for any nano-fluid related technology [2], e.g., nano-inks, chemical and biological chips.

Research Objective

• To study the effects of substrate topology on the evolution of a wetting film
• Gain better understanding of the interplay between surface tension and van der Waals.

Techniques

• Patterned silicon substrates provided by IBM [3] were characterized with microscopy and X-Ray techniques.
• X-Ray studies were done in situ at the NSLS, BNL.
• Studied the evolution of wetting film of hydrocarbon vapor (methyl-cyclohexane, C7H14) on patterned silicon.
• Film thickness controlled to Angstrom precision by varying \( \Delta T \) (temperature difference between liquid reservoir and substrate) with mK accuracy.
• X-Ray reflectivity and 2D diffraction were taken at each \( \Delta T \) to measure thickness of film on flat part of substrate and pore filling.

Selected Experimental Results

• Observed filling of nano-holes with liquid (GID).
• The evolution of the liquid layer development was traced up to thicknesses ~ 8 nm.
• Determined that thickness is being “measured” from tops of pits.

Research Summary & Conclusions

• We show well known 1/3 power law for wetting on FLAT sample
• Wetting on pattern sample show strong deviation from simple 1/3 power law!
• Data shows qualitative agreement with theory [1].
• Next step – Chemical patterned samples

References:


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