Abstract No. gang450

# Wetting of Hydrocarbon Liquid Surfaces by Fluorocarbon Vapor

O. Gang, M. Fukuto, K. Alvine, P. Huber and P. Pershan (Harvard U.)
Beamline(s): X22B

**Introduction**: The physical properties of thin fluid wetting films are in the focus of both of technological applications (coating, lubrication, adhesion) and statistical physics [1]. Liquid surfaces provide a unique opportunity to study the structure of wetting films as well as wetting phenomena on a structure-less substrate [2]. X-ray reflectivity [3] is an exceptionally powerful method to explore the normal to surface structure of thin films [4].

**Methods and Materials**: The wetting of the liquid fluorocarbon (perfluoromethylcyclohexane, PFMC) on the liquid hydrocarbon (eicosane, C20) surface was studied just above the eicosane melting point, where C20 exhibits surface freezing (SF) [5]. We control the thickness of the wetting layer [6] by changing the chemical potential of PFMC vapor relative to its liquid reservoir through temperature differences $\Delta T$ with accuracy <1mK.

**Results**: The normalized x-ray reflectivity ($R/R_F$) [4, 5, 6] were measured at 42.2 $^oC$ (Fig. 1). In absence of PFMC in the chamber, reflectivity of the bare surface of the molten C20 (O) is typical for a structure-less liquid, while the pronounced oscillation at 37.2 $^oC$ ($\Delta$) is attributed to SF phase [5]. PFMC was injected into the chamber at 37.2 $^oC$ and substrate at ~ 40.1 $^oC$. Data taken 30 minutes after PFMC injection (■) and after thermal equilibrium reached (⑩) illustrate the formation of a wetting layer of PFMC, which completely suppresses SF layer.

The thickness of the wetting film grows (~ 7 Å to 200 Å) with decreasing $\Delta T$. We observed the gradual decrease of the period of oscillations with decreasing $\Delta T$ (Fig. 2). The common envelope for all data taken above $\Delta T$=0.5mK implies the same constant electron density of the wetting film relative to the molten underlying eicosane. Some divergence from that envelope for the higher momentum transfer ($q_z$) values is caused by the contribution the film roughnesses to the x-ray reflectivity, and we systematically studied the dependence of both air-film and film-bulk roughnesses on the film thickness. The strong deviation from the common envelope that is observed at $\Delta T$=0.5mK is attributed to the finite angular resolution, as well as to macroscopic condensation on the C20 substrate, due to the vanishing difference between the chemical potentials of the adsorbed liquid and the reservoir. The equilibrium film thickness is in good agreement with the $d \sim \Delta T^{-1/3}$ dependence [1].

**Acknowledgments**: Work supported by NSF-DMR-98-72817 and Rothschild Foundation. We wish to acknowledge S. Coburn, B. Ocko and E. DiMasi for their technical support at beamline X22B of the NSLS (BNL).

**References:**

1. P. G. de Gennes, *Rev. of Mod. Phys.* **57,** 827, (1985);.B. M. Law, *Progress in Surf. Sc.* **66,**159, (2001).
2. E. Bertrand, H. Dobbs, D. Broseta, J. Indekeu, D. Bonn, & J. Meunier, *Phys. Rev. Lett.* **85,** 1282, (2000); T. Pfohl, H. Möhwald, H. Riegler *Langmuir* **14,** 5285-5291, (1998).
3. P. S. Pershan & J. Als-Nielsen, *Phys. Rev. Lett.* **2,**759, (1984).
4. R. K. Heilmann, M. Fukuto, & P.S. Pershan, *Phys. Rev. B,* **63***,* 205405-205416, (2001).
5. B. M. Ocko, X. Z. Wu, E. B. Sirota, S. K. Sinha, O. Gang, & M. Deutsch, *Phys. Rev. E* **55,** 3164 (1997).
6. I. M. Tidswell, T. A. Rabedeau, P. S. Pershan, & S. D. Kosowsky, *Phys. Rev. Lett.* **66,** 2108, (1991).

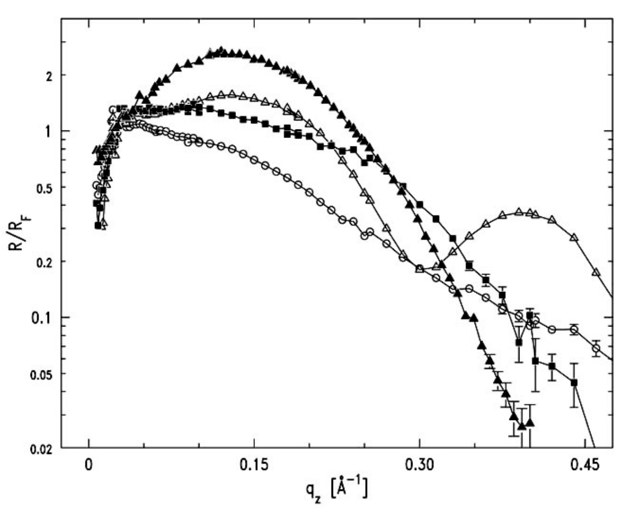


**Fig. 1**

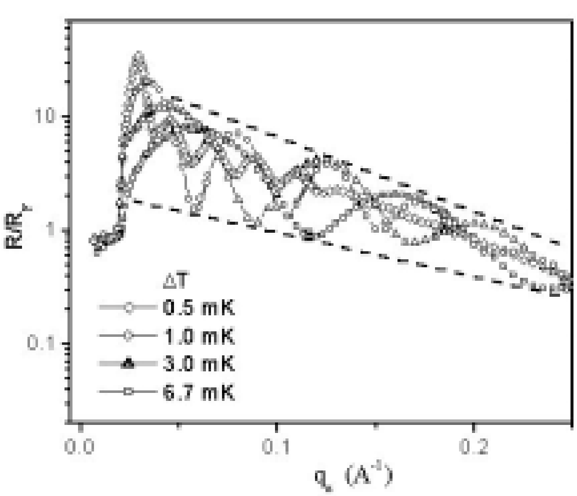


**Fig. 2**