Interfacial Dynamics of Polymers and SAMs: Glassy Dynamics, Hierarchical Assembly and the Quest for Perfection

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The formation, physical characterization, dynamical properties, and reactivity of thin films are central to our understanding of interfacial science including nanoscale systems. This presentation will focus on the characteristics of "soft" thin films, including polymers and self-assembling organic overlayers. The first part of this talk will discuss issues pertaining to defect mobility and thermal annealing, spatial organization, and the prospect for functional decoration of diblock copolymer surface structures. This effort has demonstrated that atomic force microscopy imaging can be used in a time-lapse manner to track the interactions of topological defects. Combining rules for various dislocation and disclination pairs have been established. Strong polymer alignment has been realized in dewetted annular structures and on lithographically generated grating substrates in which intentionally selected depths and widths have been used to guide the assembly of highly-aligned polymeric interfaces *via* kinetic and thermodynamically based mechanisms [1]. Recent activities have focussed on guiding the formation of phase separated polymeric structures in complex geometries, as well as the hierarchical decoration of these thin film materials with magnetic nano-particles to create functional materials [2]. The second part of the talk will examine structural and dynamical phenomena associated with self-assembling monolayers and polymeric thin films. Inelastic atom scattering in conjunction with complementary numerical simulations will examine the transition from single-phonon to many-phonon processes in gas-surface collisional energy exchange [3], including the discovery of a new channel for non-thermal and directionally specific emission of atoms embedded within these films [4]. These measurements are important as they characterize the atomic-level surface vibrational dynamics of thin films and polymers. Such measurements also probe how the properties of nanoscale thin films may differ from those characteristic of bulk materials. For example, we find that the mean-squared displacement of thicker films is slightly greater than for thinner films, giving an important glimpse on how thin-film interfacial dynamics depend on film thickness and nano-confinement. Preliminary results from new atomic beam scattering experiments which seek to probe glassy dynamics in such films will conclude this presentation [5]. It is with great pleasure that I acknowledge my collaborators: S. Bader, J. Becker, S. Darling, M. A. Freedman, K. Gibson, J. Hahm, N. Isa, D.-C. Lee, X.-M. Lin, T. Minton, I. Popova, A. Rosenbaum, D. Sundrani, Yi Wang, L. Yu, N. Yufa, and Q. Zheng.

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