Helium Ion Microscopy Imaging of Bottlebrush Copolymers

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Bottlebrush polymers are a growing class of materials with desirable properties for a wide variety of applications. [1, 2] Their functional flexibility, stemming from designed functionalization of the polymer backbone as well as the branched sidechains, offer unique assembly properties. [3] However, capturing the surface morphology as well molecular reorganization have proved to be difficult for many classical high-resolution techniques. [4] The imaging work is necessary to elucidate the structure-property relationships of these materials, in order to guide backbone and sidechain design for specific applications.

Here, we visualize the surface of a number of related fluorinated bottlebrush polymers, [5] highlighting molecular organization and periodic formation of nanoscale superstructure ordering under the influence of a helium ion beam.[6] By relying on a combination of plasma etching, HIM imaging, image analysis, and Coarse-Grained Molecular Dynamics simulation we highlight the internal structure of bottlebrush polymers in thin films at high-resolution, without a conductive coating, and extensive sample preparation, as shown in the imaged as is polymers in Figure 1.

The direct visualization and analysis workflow showcased in this work can be applied to a broad variety of polymers with different architectures, linking imaging results with other, independent channels of information for better understanding and control of these classes of materials. [7]

References:

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[7] This research was conducted at the Center for Nanophase Materials Sciences, which is a DOE Office of Science User Facility.
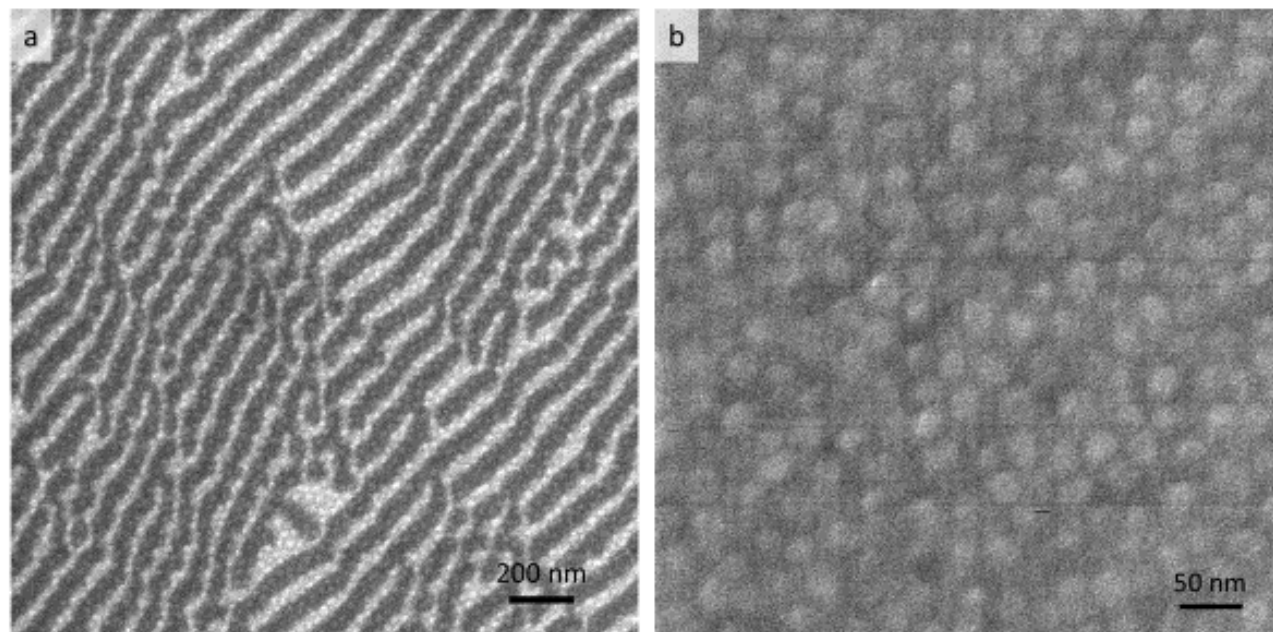
Figure 1. Helium Ion Microscopy images of P(NB28-*g*-PTFEMA20)-*b*-P(NB56-*g*-PEO8.8) surface showcasing the ion beam induced striped pattern clearly apparent in (a). (b) is a higher resolution area within (a) illustrating molecular packing of the polymer chains.