Probing chemistry and structure of polymers with energy-tunable X-rays

Gregory Su*, Isvar Cordova, Ahmet Kusoglu, William White, Lawrence Renna, Shane Ardo, David Prendergast, Cheng Wang

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Abstract

Continued progress in the development and performance of soft matter-based technologies depends critically on the ability to characterize chemistry and morphology in these systems. Energy tunable X-rays provide the ability to probe chemistry and structure through both X-ray absorption spectroscopy and resonant scattering techniques. Here, we show how spectroscopy and scattering in the soft and tender X-ray regimes coupled with first-principles calculations can be applied to soft matter systems, specifically the phase separated morphology of polymer-based membranes relevant to energy and water-treatment applications. X-rays are suitable for in situ experiments, allowing for membrane characterization in the presence of water. These methods are widely applicable to other relevant polymer systems, for example, highly orientated semiconducting polymers. These findings highlight the need for continued development in combining theory and experiment to understand polymer morphology especially as studies move toward advanced in situ, operando, and time-resolved characterization.