Abstract
Nanometer-sized thin films of small organic molecules are widely used in applications ranging from organic photovoltaics and organic light emitting diodes, to protective coatings and high resolution nano-imprint lithography. Physical vapor deposition (PVD) is widely used in manufacturing ultra-thin layers of amorphous organic solids, with an underlying assumption that the properties of these layers are bulk-like. In this presentation, I demonstrate that films of organic glass-formers with thicknesses of 30 nm or less have dynamics significantly enhanced relative to the bulk dynamics at temperatures well below the glass transition temperature, Tg. I show that a sharp glass to liquid transition exists when the thickness of the layer is changed from 40 nm down to 20 nm. This significant change in the glass dynamics is due to the enhanced mobility at the air/glass interface and the length scale over which the effects of this perturbation can propagate due correlated dynamics in the bulk glass. As such, we are able to show that these glassy systems have long-range correlated dynamics over length scales of about then times the size of the molecules, well exceeding their inter-molecular interaction range. While these measurements are important for a host of applications, they can also help elucidate the fundamental mechanisms of glass transition phenomenon, a question that have attracted numerous theoretical and experimental studies in the past half century. The results of these experiments are directly compared with some of the most well-known models of glass transition.

Bio
Zahra received her B.Sc. and M.Sc. in physics from Sharif University of Technology in Iran. In 2003, she joined Jamie Forrest’s group in university of Waterloo and studied the dynamics of polymers in thin films and on their surfaces. She received her PhD in Physics from the University of Waterloo in 2007, for which she received the American Physical Society’s Padden award. From 2007 to 2008 Zahra worked in the Gilbert Walker’s group at the University of Toronto and studied the structure and chemical composition of block copolymers and protein aggregates using near-field infrared imaging. Subsequently, Zahra moved to Mark Ediger’s group at the University of Wisconsin-Madison (2009-2011) with an NSERC post-doctoral fellowship from the Canadian government. She joined Penn Chemistry in January 2011.

Fakhraai group at Penn Chemistry explores structure and dynamics of materials at nanometer lengths scales. In 2014 Zahra received the NSF Career award to study the properties of organic glasses at interfaces and in nanometer lengths scale. These studies can help elucidate length scales of glass transition, and make ultra-stable glass films. Zahra is the recipient of 2015 Sloan fellowship in Chemistry and a co-PI of an NSF-PIRE grant for Research and Education in Active Coating Technologies (REACT) for the human habitat.