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Dynamics of end-tethered polymers chains and slip at interfaces

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End-tethered polymer chains have many interesting physical properties that gave rise to intensive theoretical and experimental studies in recent years. Those systems - called polymer brushes - can for example promote adhesion between a solid substrate and a compatible polymer network, control the friction with a melt or a network, or modify the lubrication forces between surfaces. The conformation of grafted chains, the way they entangle with the melt or the network and their dynamics determine the macroscopic properties of the interface and thus properties of composite materials. To probe this dynamics, we destabilized the equilibrium conformation of the grafted chains in three different ways and then follow their kinetics of relaxation using neutron reflectivity.
We first studied the kinetics of interdigitation between a polymer brush and a chemically identical polymer melt (polystyrene). The density profiles of the polymer brush were determined for different annealing times to quantify the kinetics of equilibration. The experimental relaxation times were found to be in good agreement with a scaling law model that we proposed inspired from the dynamics of star polymer melt.
In a second step, we studied the influence of a constant shear rate on the interface between a polymer melt and a brush. Neutron reflectivity allowed us to probe the change in the conformation of the grafted chains and gave a molecular insight of the transition from low slip to high slip that appears in those systems. Moreover, the kinetics of relaxation of a sheared polymer brush was found to be much quicker than for the interdigitation experiments. This result shows that the kinetics of relaxation of the grafted chains depends on how the interface was initially destabilized.
Our final step consists in studying the conformation and the dynamics of end tethered chains in a confined geometry. We spin coated a thin layer of d-PS onto the brush so that the total thickness of polystyrene is smaller than the extension of the brush at equilibrium. As a result, the end-tethered chains cannot fully extend in the melt and are confined between the solid substrate and the free surface. The density profiles were compared to the prediction of the Self Consistent Field Theory and their kinetics of relaxation were measured. Here, we observed how the confinement influences the dynamics of the grafted chains and proposed possible explanations for this phenomenon.