Seminar
"IRTG Soft Matter Science"

Single polymer surface diffusion

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I shall discuss the diffusion of polymer molecules on different substrates. I shall start with the situation whereby single poly(ethylene glycol) (PEG) molecules diffuse on surfaces which change from hydrophilic to hydrophobic over a few microns. These surface gradients can be fabricated rather easily by a variant of scanning near-field photolithography [1]. Such surface gradients on the macroscopic scale have the potential to control motion, such as that of water droplets moving against gravity uphill [2]. Here, the smaller are shown here to drive the polymer diffusion in the direction of the hydrophilic component. The polymer diffusion coefficients on these surfaces are measured by fluorescence correlation spectroscopy, and are shown to be elevated by more than an order of magnitude compared to surfaces without the surface energy gradient [3]. Along the gradient, the diffusion is asymmetric, with diffusion coefficients ~100 times greater in the direction of the gradient than orthogonal to it. Force spectroscopy shows that these polymers have different conformations on the hydrophobic and hydrophilic surfaces and the different conformations result in the different energies required to drive the diffusion. This diffusion can thus be explained by a simple Stokes-Einstein treatment of the surface-adsorbed polymer. Recent data on the diffusion of PEG on different poly(n-alkyl methacrylate) surfaces will also be presented. These surfaces have different glass transitions depending on the degree of the alkyl group. It is observed that the speed of the polymer on these surfaces increases around the glass transition temperature. The diffusion coefficient either side of the glass transition decreases, for reasons that are as yet unclear, although we do note some correlation of the increased PEG surface diffusion coefficient with measurements of the friction coefficient of these surfaces, which also increase at the glass transition, but decrease at higher and lower temperatures.

[1] P. Burgos, M. Geoghegan, and G. J. Leggett "Generation of molecular-scale compositional gradients in self-assembled monolayers" Nano Lett. 7 3747-52 (2007)
[2] M. K. Chaudhury and G. M. Whitesides "How to make water run uphill" Science 256 1539-41 (1992)
[3] P. Burgos, Z. Zhang, R. Golestanian, G. J. Leggett, and M. Geoghegan "Directed single molecule diffusion triggered by surface energy gradients" ACS Nano **3** 3235-43 (2009)

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You are welcome to meet Pr. Geoghegan, do not hesitate to contact Christelle Vergnat (softmattergraduate@physik.uni-freiburg.de)