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Studying Polymer Transport on Soft and Hard Surfaces[1]

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We have employed experiments and simulations to understand the factors controlling the transport of polymers on surfaces. From an experimental viewpoint we have focused on the transport of DNA (single stranded) on lipid bilayers. We show that this behavior is slaved to the mobility of the lipids. More surprisingly, it appears that the transport of molecules adsorbed on surfaces follows the same dependence on lipid mobility as for molecules incorporated into the lipid layer. The ability to control this surface diffusion through the introduction of posts or varying the strength of adsorption (by the use of an AC field normal to the surfaces) will also be studied. Theoretically we have used molecular dynamics simulations of a polymer chain of length N dissolved in explicit solvent and adsorbed as a pancake at the solid-liquid interface to discriminate between respective influences on surface diffusion of hydrodynamics and adsorption energetics. Only for analytically-smooth surfaces do we observe a strong influence of hydrodynamics; the polymer lateral diffusion constant, D, scales as $D \propto 1/N^{3/4}$, more weakly than for implicit solvent. For atomistic surface corrugation with uniform surface chemical makeup, $D \propto 1/N$ instead. This suggests that while we can understand the results for diffusion on lipid surfaces, more recent experimental observations of stronger N dependence for diffusion on hard solid surfaces originate not in hydrodynamic interactions but in spatially patchy energetic interactions.

[1]in collaboration with C. Padala, T. Desai, R. Kane, P. Keblinski (RPI), S. Granick (UIUC)