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### **New frontiers in single polymer dynamics**

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Single molecule techniques allow for the direct observation of polymer dynamics under highly non-equilibrium conditions. Until recently, however, these methods have been largely confined to linear semi-flexible DNA molecules as “model” polymer chains. This talk will show recent work from our group in extending the field of single polymer dynamics to new materials, including branched polymers and truly flexible polymer chains. In this way, we explore new questions in classical polymer physics such as the role of architecture, topology, and backbone flexibility on chain dynamics at the molecular level. Recently, we used single molecule methods to directly visualize comb-shaped DNA polymers. Macromolecular DNA combs are synthesized utilizing a hybrid enzymatic-synthetic approach, wherein chemically modified DNA branches and DNA backbones are generated in separate polymerase chain reactions, followed by graft-onto reactions via “click” chemistry. This method allows for the synthesis of dual-color DNA combs, such that the backbone and side branches can be tracked independently using single molecule fluorescence microscopy. In this way, we study the dynamic properties of single comb polymers under flow, including conformational and stretching dynamics for highly branched chains and polymer relaxation following cessation of flow. In related work, we also study the dynamics of flexible polymer chains using fluorescently-labeled single stranded DNA. We observe that truly flexible polymers exhibit key differences in dynamics compared to semi-flexible DNA. Overall, our work highlights the ways in which single molecule methods can be brought to bear on fundamental problems in polymer physics.