**Novel topological metrics of entanglement in polymers**

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Predicting polymer material properties based on chemical composition, density, crosslinking, or architecture requires bridging the gap between the properties of a single chain and those of a collection of chains. In this talk, we will see how new tools from mathematical topology can be used to measure topological entanglement in polymers of varying architectures (e.g., ring or linear). We will use Molecular Dynamics simulations of polymer melts to examine how the mathematical topology of polymers varies with molecular weight of the chains, and how these can capture refined information about the conformation of the chains. Next we will show that the topological entanglement reflected by mathematical methods indeed captures polymer entanglement effects in polymer melts and solutions. We will demonstrate this by using topology to predict a critical lengthscale in entangled polymers, the entanglement length, which is in agreement with experimental estimates. We will also show that topological entanglement correlates with viscoelastic properties of polymers through an oscillatory shear computer simulation. Finally, we examine the role of topology in microphase separation of diblock copolymers. All of these results point to the advantages of topological parameters in analyzing polymers and the emergent topological framework of modeling and prediction of material properties that arises.