Introduction

Polymers studies have historically focused on the bulk properties of homogenous fluids of linear polymers, with less emphasis directed towards ring (circular) polymers and blends of polymers of varying length or topology. Studies on ring polymers have been hindered by the fact that the production of circular synthetic polymers, without linear contaminants is a near impossibility due to the cyclization process used to convert linear polymers to rings.1-4 Several studies have been focused on the production of these ring polymers, especially when the molecules are entangled. Here, we have previously shown that entangled linear and ring polymers diffuse at different rates.5-12 The linear polymers diffuse on the surface of the contained solution, while the molecules are entangled, as the surface tension of the solution causes the linear polymers to diffuse rapidly to the surface of the solution, while the molecules are entangled, as the surface tension of the solution causes the linear polymers to diffuse rapidly to the surface of the solution.13

In this study, we have used dialysis membrane as the linear polymer matrix because it holds multiple advantages over synthetic polymers. While the creation of synthetic polymers results in samples with a limited distribution of the desired length, DNA can be replicated to create samples of nearly the same length. Moreover, the use of dialysis membrane is purely a linear polymer matrix is also possible when dealing with synthetic polymers.

Here, we use single molecule fluorescence and particle-tracking to measure self-diffusion coefficients of single DNA molecules in varying media of linear and circular DNA. Previous investigations examining polymers in bulk, have shown a complex relationship between the ratio of linear to circular polymers and viscosity.13 However, the presence of entangled rings to polyelectrolytes and the molecular dynamics of the single molecules properties remain unclear. By examining individual DNA molecules of varying lengths in varying samples of background, we can study the linear to ring constraint on self-diffusion and polymer concentration, and infer the effect of self-diffusion on polymer length.