Electrophoretic mobility of double-stranded DNA in defect-controlled polymer networks: correlation length and mesh size

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Size-based separations of polyelectrolytes (e.g. DNA) in polymer gels and polymer solutions play integral role in molecular biology. Understanding the molecular mechanisms of dynamics in polymer networks is of fundamental interest. Although numerous studies have been done and a number of models have been proposed, not a single model can explain the full extent of the experimental data.[1] Inhomogeneity and uncontrollability of the polymer networks of conventional polymer gels are the main reasons that prevent progress of understanding. Recently, we fabricated a new polymer gel with extremely homogeneous network, Tetra-PEG gel.[2] By conducting a systematic study in this gel, we successfully revealed the framework of the migration in polymer networks. Migration of polyelectrolytes in polymer gels is governed by two different mechanisms (reptation and entropic barrier) simultaneously.[3]

However, our framework found in gels with ideal polymer networks may not be valid in conventional gels, which have inhomogeneous networks. In this study, we purposely added defects in polymer networks of Tetra-PEG gels and conducted a systematic study to investigate the migration behavior of double-stranded DNA in the polymer networks with defects. These defects in polymer networks influenced the variables inside the entropic barrier term, but the framework was the same with that in ideal polymer networks. Whereas correlation lengths obtained from SANS measurement did not show any explainable relationship with the migration behavior, distance between crosslinks obtained by theoretical calculation exhibited unique relationships with the migration behavior of short rigid rod-like double-DNA molecules.

References

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