Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Prediction of scaling law for particle diffusion in polymer solutions TAI-HSI FAN, University of Connecticut, USA, REMCO TUINIER, Forschungszentrum Jlich, IFF - Soft Matter, Germany — Particle diffusion plays an important role affecting mass transport and reaction kinetics in many biological systems. In a crowded physiological microenvironment, diffusion transport of particles or macromolecules is hindered by the background biopolymers such as proteins and polysaccharides. In a simplified model system, such hindering or retardation effect is often described by a stretched exponential function, $R = \exp(Ka^{\mu}c^{\nu})$, where R is the empirical retardation factor to be measured from the particle's apparent diffusivity in polymer solutions, a is the particle size, c is the bulk polymer concentration, and the coefficient $K$and exponential scaling exponents μ and ν are empirical parameters. A few hypotheses were proposed to rationalize the scaling exponents, but there is yet no satisfactory theoretical proof that R can be expressed in such a general fashion. We propose analytical and numerical models to compute the retardation effect based on continuum fluid flow analysis and polymer depletion theory. The three important empirical parameters are predicted for both dilute and semidilute polymer solutions. The found scaling law resembles the nominal values of the exponential exponents from collected experimental data, providing a promising explanation for the polymer-mediated retardation effect.

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Date submitted: 03 Aug 2007

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