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Diffusion of Nanoparticles in Semidilute Polymer Solutions: The Effect of Different Length Scales. INDERMEET KOHLI, ASHIS MUKHOPADHYAY, Wayne State University — Gold nanoparticles (Au NPs) were used to investigate the length-scale dependent dynamics in semidilute poly(ethylene glycol) (PEG)-water solutions. Fluctuation correlation spectroscopy was used to measure the diffusion coefficients (D) of the NPs as a function of their radius, R_o (2.5-10 nm), PEG volume fraction, ϕ (0-0.37) and molecular weight, M_w (5 kg/mol and 35 kg/mol). Our results indicate that the radius of gyration, R_g of the polymer chain is the crossover length scale for the NPs experiencing nanoviscosity or macroviscosity. The reduced diffusivity can be plotted on a single master curve as $D_o/D = \exp(\alpha(R_o/\xi)^\delta)$ for $R_g > R_o$ and as $D_o/D = \exp(\alpha(R_g/\xi)^\delta)$ for $R_g \leq R_o$, where D_o is diffusion coefficient in the neat solvent, ξ is the correlation length, $\alpha = 1.63$ and $\delta = 0.89$. In the intermediate size regime, $\xi < R_o < a(\phi)$, where '$a(\phi)$' is the tube diameter for entangled polymer liquid, we found that $D \sim \phi^{-1.45}$ and independent of M_w. For $R_o > a(\phi)$, $D \sim \phi^{-4}$ was obtained. The results were compared with currently available theories.

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