

Abstract Submitted
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Universal Scaling of Polymer Diffusion in Nanocomposites JIHOON CHOI, MICHAEL J.A. HORE, Department of Materials Science and Engineering, University of Pennsylvania, JEFFREY S. METH, DuPont Nanocomposite Technologies, Central Research & Development, NIGEL CLARKE, Department of Physics and Astronomy, The University of Sheffield, KAREN I. WINEY, RUSSELL J. COMPOSTO, Department of Materials Science and Engineering, University of Pennsylvania — The tracer diffusion of deuterated polystyrene (dPS) is measured in a polystyrene (PS) nanocomposite containing hard and soft silica nanoparticles (NPs). The soft NPs are grafted with a PS brush (87 kg/mol). The matrix for both NPs is PS (160 kg/mol). The diffusion coefficients for dPS (23 - 1,866 kg/mol) decrease as the hard and soft NP volume fractions increase. To accurately determine the interparticle distances (ID) relevant to each dPS (M) diffusing through the PS(160k):soft NP matrix, self consistent field theory and small angle neutron scattering studies were performed; both theory and experiment show that short dPS chains can deeply penetrate the brush, whereas longer dPS chains only penetrate the periphery and mainly remain in the matrix. The reduced diffusion coefficient (D/D_0), plotted against the confinement parameter, namely ID relative to tracer size ($2R_g$), collapses onto a master curve independent of NP type. These experiments demonstrate that polymer diffusion in nanocomposites is captured by the confinement parameter over an extremely wide range of $ID/2R_g$ and, hopefully, motivate new models to capture the dynamics in confined ($ID/2R_g < 10$) regimes.

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