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Communication: Proton NMR dipolar-correlation effect as a method for investigating segmental diffusion in polymer melts

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Abstract

© 2016 Author(s).A simple and fast method for the investigation of segmental diffusion in high molar mass polymer melts is presented. The method is based on a special function, called proton dipolar-correlation build-up function, which is constructed from Hahn Echo signals measured at times t and t/2. The initial rise of this function contains additive contributions from both inter- and intramolecular magnetic dipole-dipole interactions. The intermolecular contribution depends on the relative mean squared displacements (MSDs) of polymer segments from different macromolecules, while the intramolecular part reflects segmental reorientations. Separation of both contributions via isotope dilution provides access to segmental displacements in polymer melts at millisecond range, which is hardly accessible by other methods. The feasibility of the method is illustrated by investigating protonated and deuterated polybutadiene melts with molecular mass 196 000 g/mol at different temperatures. The observed exponent of the power law of the segmental MSD is close to 0.32 ± 0.03 at times when the root MSD is in between 45 Å and 75 Å, and the intermolecular proton dipole-dipole contribution to the total proton Hahn Echo NMR signal is larger than 50% and increases with time.

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