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Self and collective dynamics in a highly crosslinked polybutadiene rubber

In recent years, a great effort has been put to investigate collective relaxations in liquids [1] and polymer systems [2] at mesoscopic scales. This has been experimentally achieved using neutron scattering methods, especially in combination with polarization analysis (PA) capabilities [3] allowing to disentangle incoherent and coherent contributions, or with computational methods [4]. Few neutron spectrometers currently allow PA, and the method has also limitations due to reduced neutron flux. Here we present the results of the investigation of a crosslinked rubber of deuterated 1,2-polybutadiene (d1,2-PB), where we use an alternative approach and combine different neutron spectrometers to separate self and collective dynamics [5]. In the neat polymer melt the collective segmental relaxation around the structure factor peak $S(Q_{max})$ shows de Gennes narrowing, with a collective relaxation time $\tau_c(Q)$ that increases without plateauing towards lower Q_s . In the crosslinked d1,2-PB rubber, the peak at $S(Q_{max})$ is reduced and instead a strong low- Q peak emerges. Both the collective d1,2-PB relaxation rates around the former $S(Q_{max})$ and the relaxation around the new crosslink correlation peak are significantly slowed down compared to the melt. Finally, the cross-linking strands exhibit their own fast dynamics, which is well described by diffusion within a spherical Gaussian well.

Session

Soft Condensed Matter

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