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Self-similar structure and dynamics of polymer rings.

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Small Angle Neutron Scattering (SANS) and Neutron Spin Echo (NSE) results on very large poly(ethylene-oxide) (PEO) rings in the melt are presented [1,2]. The ring conformation demonstrate a clear signature of the theoretically predicted elementary loops. Their size is in the range of an entanglement strand for linear PEO melts and they are characterized by Gaussian statistics. The ring chain length dependence of the radius of gyration Rg follows rather closely the prediction of decorated ring model [3]. Other than extracted from numerous simulations that are interpreted in terms of a cross over to mass fractal, such a cross over was not observed by SANS. We could also clarify the unique topology driven self-similar ring dynamics and distinguish between different scaling theories. While the dynamics of linear and branched polymers is dominated by the celebrated reptation mechanism, where a polymer creeps out of its topological confinement via its ends, polymer rings featuring no ends cannot undergo reptation but are supposed to perform self-similar dynamics. We present NSE experiments on the initial anomalous center of mass diffusion and the internal dynamics of large polymer rings –a field of broad interest that so far has exclusively been accessed by theory and simulations.

[1] M. Kruteva et al. ACS Macro Lett. 9 (2020) 507–511
[2] M. Kruteva et al. Phys. Rev. Lett., submitted
[3] S. Obukhov et al. EPL 105 (4) (2014) 48005

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