Chain dimension of ring polymers in bulk

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Ring polymer has topologically interesting architecture without chain ends and it is considered as a model polymer to investigate the topological effect on physical properties. One of the interesting properties representing ring polymers is the chain dimensions in bulk. Generally radius of gyration R_g of polymer can be expressed by the function of degree of polymerization N,

$$R_g \sim N^{\nu}$$

where ν is Flory's scaling exponent[1]. Theoretically ν for linear polymer in bulk is 1/2 and the scaling exponent was experimentally proved by small-angle neutron scattering (SANS) experiments[2]. However theories and computer simulations predicted ν for ring polymer in bulk is between 1/2 and 1/3[3]-[4]. Furthermore recent simulations predicted ν for ring polymer in bulk is changed three steps (1/2→2/5→1/3) with increasing N[5]-[6]. Experimentally Arrighi et al. reported ν for ring polydimethylsiloxanes in bulk was 0.42, but the molecular weight range for a series of ring samples used was rather short (3k≦Mw≦9k), and the purity of the samples were unknown[7].

In this study, a series of highly-purified ring polystyrenes with molecular weight ranging of 16k≦M_w≦380k were carefully prepared by anionic polymerization and HPLC separation techniques. From the SANS measurements using the purified ring samples, the molecular weight dependence on radius of gyration of ring polymers in bulk was investigated, and compared with predicted theories and computer simulations.

References

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