Abstract Submitted
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Dynamics of Bottlebrush Networks[1] ZHEN CAO, University of Akron, WILLIAM DANIEL, MOHAMMAD VATANKHAH-VARNOSFADERANI, SERGEI SHEIKO, Univ of NC - Chapel Hil, ANDREY DOBRYNIN, University of Akron — The deformation dynamics of bottlebrush networks in a melt state is studied using a combination of theoretical, computational, and experimental techniques. Three main molecular relaxation processes are identified in these systems: (i) relaxation of the side chains, (ii) relaxation of the bottlebrush backbones on length scales shorter than the bottlebrush Kuhn length ($b_{\rm K}$), and (iii) relaxation of the bottlebrush network strands between cross-links. The relaxation of side chains having a degree of polymerization (DP), $n_{\rm sc}$, dominates the network dynamics on the time scales $\tau_0 < t \leq \tau_{\rm sc}$, where τ_0 and $\tau_{\rm sc} \approx \tau_0(n_{\rm sc}+1)^2$ are the characteristic relaxation times of monomeric units and side chains, respectively. In this time interval, the shear modulus at small deformations decays with time as $G_0^{\rm BB}(t) \sim t^{-1/2}$. On time scales $t > \tau_{\rm sc}$, bottlebrush elastomers behave as networks of filaments with a shear modulus $G_0^{\rm BB}(t) \sim (n_{\rm sc}+1)^{-1/4}t^{-1/2}$. Finally, the response of the bottlebrush networks becomes time independent at times scales longer than the Rouse time of the bottlebrush network strands. In this time interval, the network shear modulus depends on the network molecular parameters as $G_0^{\rm BB}(t) \sim (n_{\rm sc}+1)^{-1}N^{-1}$. Analysis of the simulation data shows that the stress evolution in the bottlebrush networks during constant strain-rate deformation can be described by a universal function.

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