

MAR11-2011-020259

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

Bottle-brush polymers versus worm-like chains: Do we understand the stiffness of macromolecules?

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Bottle-brush polymers contain a long flexible macromolecule as a backbone to which flexible side-chains are grafted. Through the choice of the grafting density of the length of the side chains to the local stiffness of this cylindrical molecular brush can be controlled. However, understanding mesoscopic length scales (cross-sectional radius, persistence length, contour length) of these semiflexible cylindrical brushes poses a challenging problem. While self-avoiding walks of variable stiffness show a crossover to the Kratky-Porod worm-like chain model, and hence a (pre-asymptotic) regime of Gaussian behavior, bottle-brushes under good solvent conditions are not compatible with this model. Consequences for the description of chain stiffness in terms of the concept of the persistence length are discussed, as well as pertinent experiments.