

Universal Scaling Laws for Cluster Growth and Aging During Collapse of a Polymer

Suman Majumder and Wolfhard Janke

*Institute für Theoretische Physik, Universität Leipzig, Postfach 100
920, D-04009 Leipzig, Germany*

Using state of the art Monte Carlo simulations of a bead-spring model we investigate the homopolymer collapse by quenching the homopolymer from an expanded coiled state into the globular phase. The sequence of events observed during the collapse is independent of the quench depth. In particular, we focus on finding out universal scaling behaviors related to the growth or coarsening of clusters of monomers, by drawing phenomenological analogies with ordering kinetics. We distinguish the cluster coarsening stage from the initial stage of primary cluster formation. By successful application of a nonequilibrium finite-size scaling analysis we show that at all quench temperatures, during the coarsening stage, the cluster growth is roughly linear and can be characterised by a universal finite-size scaling function. In addition, we provide evidence of aging by constructing a suitable autocorrelation function and its corresponding dynamical power-law scaling with respect to the growing cluster sizes. The predicted theoretical bound for the exponent governing such scaling is strictly obeyed by the numerical data irrespective of the quench temperature. The results and methods presented here in general should find application in similar phenomena such as the collapse of a protein molecule preceding its folding.