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Critical Behavior of Two Interacting Linear Polymer Chains in a Good Solvent

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A model of two interacting (chemically different) linear polymer chains is solved exactly using the real-space renormalization group transformation on a family of Sierpinski gasket type fractals and on a truncated 4-simplex lattice. The members of the family of the Sierpinski gasket-type fractals are characterized by an integer scale factor b which runs from 2 to ∞. The Hausdorff dimension d_F of these fractals tends to 2 from below as $b \to \infty$. We calculate the contact exponent y for the transition from the state of segregation to a state in which the two chains are entangled for $b = 2$–5. Using arguments based on the finite-size scaling theory, we show that for $b \to \infty$, $y = 2 - \nu(b)\, d_F$, where ν is the end-to-end distance exponent of a chain. For a truncated 4-simplex lattice it is shown that the system of two chains either remains in a state in which these chains are intermingled in such a way that they cannot be told apart, in the sense that the chemical difference between the polymer chains completely drop out of the thermodynamics of the system, or in a state in which they are either zipped or entangled. We show the region of existence of these different phases separated by tricritical lines. The value of the contact exponent y is calculated at the tricritical points.

KEY WORDS: Segregation; entanglement; tricritical line; contact exponent; finite-size scaling; fractals.

1. INTRODUCTION

In order to explain the entanglement and segregation of polymer chains in a solution a lattice model of two interacting self-avoiding-walks (SAWs) has recently been proposed.[1] In this model walks were allowed to cross each other at most once on a lattice point and a lattice bond was allowed to be occupied at most by a step of one or by both walks. This model hereinafter referred to as a model of two interacting crossed walks or

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those of (say) $2b$-fractal. This analysis clearly indicates that $y = \alpha$ is satisfied only for a lattice for which the resealing parameter b approaches infinity.

The model which we solved for a 4-simplex lattice has an additional parameter, viz., $u = \exp(E_n/T)$ where E_n is the attraction energy between a pair of unlike monomers occupying nearest neighbor lattice sites. It is shown that the two attraction parameters ω and u compete with each other. While ω favors formation of entangled configuration of two chains, u, on the other hand, favors zipping of the chains. The phase diagram plotted in Fig. 4 shows the region of existence of these phases.

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