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Statistical mechanics of polymer chains grafted to adsorbing boundaries of fractal lattices embedded in three-dimensional space

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HIGHLIGHTS

- Self-avoiding walk model of polymers near an adsorbing fractal surface is studied.
- Polymers are situated on three-dimensional lattices of Sierpinski gasket family of fractals.
- Exact and very precise Monte Carlo results are obtained for various polymer configurations.

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ABSTRACT

We study the adsorption problem of linear polymers, immersed in a good solvent, when the container of the polymer–solvent system is taken to be a member of the Sierpinski gasket (SG) family of fractals, embedded in the three-dimensional Euclidean space. Members of the SG family are enumerated by an integer b ($2 \le b < \infty$), and it is assumed that one side of each SG fractal is impenetrable adsorbing boundary. We calculate the surface critical exponents γ_{11}, γ_1, and γ_s which, within the self-avoiding walk model (SAW) of polymer chain, are associated with the numbers of all possible SAWs with both, one, and no ends grafted to the adsorbing surface (adsorbing boundary), respectively. By applying the exact renormalization group method, for $2 \le b \le 4$, we have obtained specific values for these exponents, for various types of polymer conformations. To extend the obtained sequences of exact values for surface critical exponents, we have applied the Monte Carlo renormalization group method for fractals with $2 \le b \le 40$. The obtained results show that all studied exponents are monotonically increasing functions of the parameter b, for all possible polymer states. We discuss mutual relations between the studied critical exponents, and compare their values with those found for other types of lattices, in order to attain a unified picture of the attacked problem.

1. Introduction

The conformational characteristics of flexible polymer chains, immersed in various types of solvent, near an adsorbing substrate have been extensively studied because of their practical importance in technology and biological physics, and, as a surface critical phenomenon of modern statistical physics [1–3]. In almost all theoretical studies of the linear polymer

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