Journal of Statistical Physics, Vol. 71, Nos. 1/2, 1993

Adsorption of a Flexible Self-Avoiding Polymer Chain: Exact Results on Fractal Lattices

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Received September 3, 1992

The large-scale behavior of surface-interacting self-avoiding polymer chains placed on finitely ramified fractal lattices is studied using exact recursion relations. It is shown how to obtain surface susceptibility critical indices and how to modify a scaling relation for these indices in the case of fractal lattices. We present the exact results for critical exponents at the point of adsorption transition for polymer chains situated on a class of Sierpinski gasket-type fractals. We provide numerical evidence for a critical behavior of the type found recently in the case of bulk self-avoiding random walks at the fractal to Euclidean crossover.

KEY WORDS: Polymer adsorption; fractals; scaling relations.

1. INTRODUCTION

Configurational properties of polymer chains in the vicinity of an interface can be strongly modified relative to their bulk characteristics. A subtle competion between the gain of internal energy and a corresponding loss of configurational entropy when a portion of the chain is brought from the bulk to the attractive wall governs the large-scale behavior of the surface-interacting polymers. The subject has been in the focus of both experimental and theoretical activity.[1–3] This interest has been further enhanced by the possible application of polymer adsorption phenomena in numerous practical and technological problems.[4] The general picture that emerges from these studies reveals that, under certain conditions, polymer chains can form a self-similar adsorbed layer near the wall with a decreasing

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0022-4715/93/0400-0001$07.00/0

5. E. Eisenriegler, K. Kremer, and K. Binder, *J. Chem. Phys.* **77**:6296 (1982).
6. K. Binder, in *Phase Transitions and Critical Phenomena*, Vol. 8, C. Domb and J. L. Lebowitz, eds. (Academic Press, New York, 1983).
7. H. Meirovitch and S. Livne, *J. Chem. Phys.* **88**:4507 (1988).
8. F. Seno and A. L. Stella, *Europhys. Lett.* **7**:605 (1989).
9. T. Ishinabe, *J. Chem. Phys.* **76**:5589 (1982).
10. K. De'Bell, T. Lookman, and S. G. Whittington, *Phys. Rev. A* **41**:682 (1990).
11. I. Guim and T. Burkhardt, *J. Phys. A* **22**:1131 (1989).
12. A. R. Veal, J. M. Yeomans, and G. J. Jug, *J. Phys. A* **24**:827 (1991).
13. K. Kremer, *J. Phys. A* **16**:4333 (1983).
14. M. Benhamou and G. Mahoux, *J. Phys.* (Paris) **49**:577 (1988), and references therein.
15. B. Duplantier and H. Saleur, *Phys. Rev. Lett.* **57**:3179 (1986).
16. T. W. Burkhardt, E. Eisenriegler, and I. Guim, *Nucl. Phys. B* **316**:559 (1989).
17. G. H. Weiss and R. J. Rubin, *Adv. Chem. Phys.* **52**:363 (1983).
18. V. Privman, G. Forgacs, and H. L. Frisch, *Phys. Rev. B* **37**:9897 (1988).
19. E. Bouchaud and J. Vannimenus, *J. Phys.* (Paris) **50**:2931 (1989).
20. J. Vannimenus, *Physica D* **38**:351 (1989).
21. S. Elezović, M. Knežević, and S. Milošević, *J. Phys. A* **20**:1215 (1987).
22. D. Dhar, *J. Phys.* (Paris) **49**:397 (1988).
23. S. Milošević and I. Živić, *J. Phys. A* **24**:L833 (1991).
24. B. Nienhuis, *Phys. Rev. Lett.* **49**:1062 (1982).
25. D. Dhar, *J. Math. Phys.* **18**:577 (1977).
26. D. Dhar, *J. Math. Phys.* **19**:5 (1978).
27. B. Duplantier, *J. Stat. Phys.* **54**:581 (1989).
28. M. Knežević, unpublished.
29. J. A. Given and B. B. Mandelbrot, *J. Phys. A* **16**:L56 (1983).
30. B. Derrida and H. Herrmann, *J. Phys.* (Paris) **44**:1365 (1984).
31. B. Bonnier, Y. Leroyer, and C. J. Meyers, *J. Phys.* (Paris) **48**:533 (1987).