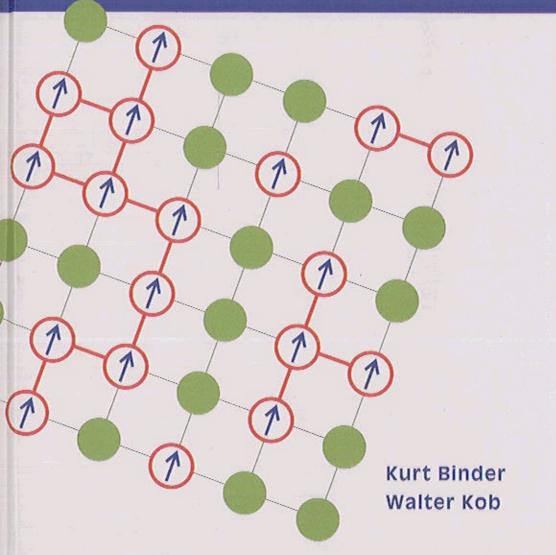
GLASSY MATERIALS AND DISORDERED SOLIDS

An Introduction to Their Statistical Mechanics



Contents

Pr	eface		v		
1.	Introduction				
	1.1	Models of Disordered Matter: A Brief Overview			
	1.2 General Concepts on the Statistical Mechanics of				
		Disordered Matter			
		1.2.1 Lattice Models	13		
		1.2.2 Averaging in Random Systems: Quenched versus			
		Annealed Disorder	17		
		1.2.3 "Symmetry Breaking" and "Ergodicity Breaking"	20		
		1.2.4 Configurational Entropy versus "Complexity",			
		and the Kauzmann Paradox	25		
2.	Structure and Dynamics of Disordered Matter				
	2.1	1 Pair Distribution Functions and the Static Structure Factor			
	2.2	Topological Disorder and Bond Orientational Correlations			
	2.3				
	Transport Properties		63		
3.	Models of Disordered Structures				
	3.1 Random Walks: A Simple Model for the Configura				
		Flexible Polymers	79		
	3.2 Percolation: A First Example of a Fractal Structu		94		
		3.2.1 The Percolation Probability and Percolation			
		Threshold	94		

viii Contents

		3.2.2	Diluted Magnets and Critical Exponents	98		
		3.2.3	The Fractal Dimensionality and the Concept of			
			Finite Size Scaling	104		
		3.2.4	Scaling of the Cluster Size Distribution	106		
		3.2.5	Percolation for Low and High Lattice Dimensions	109		
		3.2.6		113		
	3.3	Other Fractals (Diffusion-Limited Aggregation, Random				
		Surfaces, etc.)				
		3.3.1	General Concepts on Fractal Geometry	116		
		3.3.2	Diffusion-Limited Aggregation	120		
		3.3.3	Growth of Random Interfaces	122		
	3.4	Rande	om Close Packing	124		
	3.5	Continuous Random Networks				
	3.6	Chem	sically Realistic Models of Structural Glasses	139		
4.	Gen	General Concepts and Physical Properties of Disordered Matter				
	4.1	The Rouse Model for Polymer Dynamics: A Simple				
			ple for the Consequences of the Random Walk			
		Picture				
	4.2	Application of the Percolation Problem to Physical				
		System		178		
		4.2.1	Percolation Conductivity and a Naive Treatment			
		•	of the Elasticity of Polymer Networks	178		
		4.2.2	Excitations of Diluted Magnets Near the			
			Percolation Threshold	183		
		4.2.3	Effective Medium Theory	188		
	4.3	Eleme	entary Excitations of Fractal Structures	190		
		4.3.1	Diffusion on a Percolation Cluster:			
			The "Ant in the Labyrinth"	190		
		4.3.2	The Spectral Dimension and Fracton Excitations	193		
		4.3.3	The Sol-Gel Transition Revisited	198		
	4.4	Physical Properties of Amorphous Solids				
		4.4.1	Two-Level Systems	202 203		
		4.4.2	Anomalies of Glasses at Intermediate Temperatures:			
			Excess Specific Heat, Thermal Conductivity			
			Plateau, and Boson Peak	210		

Contents ix

	4.5	Spin 6	Glasses	221		
		4.5.1	Some Experimental Facts about Spin Glasses:			
			Systems and Physical Properties	222		
		4.5.2	Theoretical Models	233		
		4.5.3	The Replica Method and the Mean Field Theory			
			of the Ising Spin Glass	237		
		4.5.4	Replica Symmetry Breaking	245		
		4.5.5	Spin Glasses Beyond Mean Field Theory	255		
	4.6	Variants and Extensions of Spin Glasses				
		4.6.1	p-Spin Interaction Spin Glasses and the Random			
			Energy Model	263		
		4.6.2	Potts Glasses	264		
		4.6.3	Quadrupolar Glasses as Models for Diluted			
			Molecular Crystals	276		
		4.6.4	Atomistically Realistic Models of Diluted			
			Molecular Crystals	281		
		4.6.5	Spin Models with Quenched Random Fields	285		
5.	Supercooled Liquids and the Glass Transition					
	5.1	Phene	omenology of Glass-Forming Systems	312		
	5.2	ls for Slow Relaxation	331			
		5.2.1	The Theory of Adam and Gibbs	332		
		5.2.2	The Free Volume Theory	338		
		5.2.3	Kinetically Constrained Models	345		
	5.3	The N	Mode-Coupling Theory of the Glass Transition	359		
		5.3.1	The Zwanzig-Mori Projection Operator Formalism	360		
		5.3.2	The Mode-Coupling Approximations	364		
		5.3.3	The Mode-Coupling Theory of the Glass Transition	366		
		5.3.4	Predictions of Mode-Coupling Theory	375		
		5.3.5	The Relaxation Dynamics of Glass-Forming Liquids			
			and Test of the Predictions of MCT	385		
		5.3.6	Concluding Remarks on Mode-Coupling Theory	412		
Inc	dex			431		