Phase Transitions in Materials

Description: Offering a fresh viewpoint on phase changes and the thermodynamics of materials, this textbook covers the thermodynamics and kinetics of the most important phase transitions in materials science, spanning classical metallurgy through to nanoscience and quantum phase transitions. Clear, concise and complete explanations rigorously address transitions from the atomic scale up, providing the quantitative concepts, analytical tools and methods needed to understand modern research in materials science. Topics are grouped according to complexity, ensuring that students have a solid grounding in core topics before they begin to tackle more advanced material, and are accompanied by numerous end-of-chapter problems. With explanations firmly rooted in the context of modern advances in electronic structure and statistical mechanics, and developed from classroom teaching, this book is the ideal companion for graduate students and researchers in materials science, condensed matter physics, solid state science and physical chemistry.

Contents:

Part I - Basic Thermodynamics and Kinetics of Phase Transformations:
1. Introduction;
2. Essentials of T-c phase diagrams;
3. Diffusion;
4. Nucleation;
5. Effects of diffusion and nucleation on phase transformations;

Part II - The Atomic Origins of Thermodynamics and Kinetics:
6. Energy;
7. Entropy;
8. Pressure;
9. Atom movements with the vacancy mechanism;

Part III - Types of Phase Transformations:
10. Melting;
11. Transformations involving precipitates and interfaces;
12. Spinodal decomposition;
13. Phase field theory;
14. Method of concentration waves and chemical ordering;
15. Diffusionless transformations;
16. Thermodynamics of nanomaterials;
17. Magnetic and electronic phase transitions;
18. Phase transitions in quantum materials;

Part IV - Advanced Topics:
19. Low temperature analysis of phase boundaries;
20. Cooperative behavior near a critical temperature;
21. Elastic energy of solid precipitates;
22. Statistical kinetics of ordering transformations;
23. Diffusion, dissipation, and inelastic scattering;
24. Vibrational thermodynamics of materials at high temperatures.

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