



UNIVERSIDAD NACIONAL DE ENTRE RÍOS
FACULTAD DE INGENIERIA
CENTRO DE MEDIOS
BIBLIOTECA

Nº 2670

CONTENTS

PREFACE	xiii
FOREWORD TO THE STUDENT	xvii
1 INTRODUCTION	3
1.1 What is Materials Science? 3	
1.2 What is Structure? 22	
1.3 What are Properties? 32	
1.4 How is Materials Science Relevant? 45	
REFERENCES 53	
PROBLEMS 54	
2 MECHANICAL PROPERTIES	59
2.1 Plastic Deformation of Solids 59	
2.2 Special Deformation Behavior of Solids 65	
2.3 The Flow of Fluids 74	
2.4 Internal Friction in Solids 77	
2.5 Ideal Plastic Behavior 85	
REFERENCES 86	
PROBLEMS 87	
3 ELECTRIC AND MAGNETIC PROPERTIES	95
3.1 Introduction 95	
3.2 Ohm's Law and the Hall Coefficient 99	
3.3 Metals and Semiconductors 104	
3.4 Insulators 109	
3.5 Special Dielectrics 117	

3.6	Magnetic Properties	122
3.7	Soft Ferromagnetics	130
3.8	Hard Magnetic Materials	134
3.9	Special Magnetic Materials	136
3.10	Superconductors	137
	REFERENCES	142
	PROBLEMS	144

4 THERMAL AND CHEMICAL PROPERTIES

151

4.1	Space Rockets and Thermal Expansion Coefficient	151
4.2	Thermal Conductivity	153
4.3	Heat Capacity	159
4.4	Energy Changes During Phase Transformation	161
4.5	Temperature Effects on Properties	162
4.6	Electrical-Thermal Coupling	165
4.7	Heat Treatment	168
4.8	Chemical Properties	169
4.9	Summary of Properties	172
	REFERENCES	174
	PROBLEMS	175

5 BINDING IN ATOMS, MOLECULES AND CRYSTALS

179

5.1	Wave Mechanics	179
5.2	The Schrödinger Equation	187
5.3	The Hydrogen Atom	193
5.4	The Hydrogenlike Atom and the Periodic Table	196
5.5	Bonding of Atoms in Molecules and Condensed Phases	202
5.6	Covalent Bonding	208
5.7	Binding in Metals	213
5.8	Secondary Bonds	214
5.9	Polarization and Magnetization	220
	REFERENCES	225
	PROBLEMS	225

6 ATOMIC ARRANGEMENTS

233

6.1	Crystals and Lattices	233
6.2	Some Simple Crystals	238
6.3	Crystallographic Directions and Planes	242
6.4	Packing of Atoms in Crystals	247

6.5	Symmetry and its Relationship to Properties	261	
6.6	Imperfections in Crystals	267	
6.7	Glasses	283	
6.8	Diffraction by Crystals	288	
	REFERENCES	293	
	PROBLEMS	295	
7	POLYMERS		303
7.1	Introduction	303	
7.2	An Idealized Random Chain	306	
7.3	Degree of Polymerization	307	
7.4	The Topology of Vinyl Polymers	310	
7.5	Other Addition Polymers	314	
7.6	Copolymers	318	
7.7	Condensation Polymers	319	
7.8	Network Polymers	324	
7.9	Thermoplastics and Thermosetting Resins	326	
7.10	Crystallinity in Polymers	326	
7.11	Macromolecules in Living Matter	328	
	REFERENCES	332	
	PROBLEMS	333	
8	MICRO- AND MACRO-STRUCTURE		337
8.1	Single Crystals	337	
8.2	The Reflection Microscope	339	
8.3	Polycrystalline Materials	347	
8.4	Polyphase Materials	353	
8.5	Composite Materials	355	
8.6	Quantitative Microscopy	363	
	REFERENCES	365	
	PROBLEMS	366	
9	EQUILIBRIUM AND KINETICS		369
9.1	Atom Motion and Temperature	369	
9.2	Kinetics in an Ideal Gas	376	
9.3	Internal Energy	380	
9.4	Randomness and Entropy	382	
9.5	Equilibrium in Chemical Systems	386	
9.6	The Barometric Formula	389	

- 9.7 Atom Vibrations 392
- 9.8 Kinetics of Reactions 396
- 9.9 Introduction to Diffusion 399
- 9.10 Special Cases of Diffusion 406
- 9.11 Applications of Diffusion Theory 415
- 9.12 Nucleation 419
 - REFERENCES 424
 - PROBLEMS 424

10 PHASE DIAGRAMS

431

- 10.1 Introduction 431
- 10.2 Binary Systems 435
- 10.3 Nonequilibrium Transformations 447
- 10.4 Age Precipitation Hardening 453
- 10.5 The Fe-C System 458
- 10.6 Segregation in Binary Alloys During Solidification 468
 - REFERENCES 473
 - PROBLEMS 474

11 ELECTROCHEMICAL PROPERTIES

479

- 11.1 Introduction 479
- 11.2 Half-Cell Potentials 485
- 11.3 Polarization and Overvoltage 491
- 11.4 Corrosion 496
- 11.5 Protecting Against Corrosion 501
 - REFERENCES 505
 - PROBLEMS 506

12 STRENGTHENING MECHANISMS

511

- 12.1 How Strong Can Materials Be? 511
- 12.2 Why are Bulk Materials so Weak? 518
- 12.3 General Strengthening Concepts 527
- 12.4 Solute Strengthening 529
- 12.5 Strain Hardening 530
- 12.6 Strengthening by Grain Boundaries 538
- 12.7 Second Phase Strengthening 540
- 12.8 Strengthening by Martensitic Transformation 547
- 12.9 Strengthening at High Temperatures 553
- 12.10 Strengthening Mechanisms in Polymers 559

12.11	Strengthening of Viscous Matrices	560
	REFERENCES	561
	PROBLEMS	562
13	ELECTRONS IN CONDENSED PHASES	567
13.1	The Electron Gas	567
13.2	The Quantized Electron Gas	571
13.3	Electrons in a Periodic Potential	579
13.4	Brillouin Zones	582
13.5	Conductivity	585
13.6	Intrinsic Semiconductors	593
13.7	Extrinsic Semiconductors	596
13.8	The p-n Junction	602
13.9	The Junction Transistor	608
13.10	Lasers	611
	REFERENCES	615
	PROBLEMS	615
14	MAGNETISM	621
14.1	Diamagnetism	621
14.2	Paramagnetism	624
14.3	Ferromagnetism	632
14.4	Antiferromagnetism and Ferrimagnetism	636
14.5	Domains	639
14.6	Magnetization Processes According to Domain Theory	645
14.7	Magnetic Bubbles	650
	REFERENCES	653
	PROBLEMS	654
15	SUPERCONDUCTIVITY	657
15.1	The Superconducting State	657
15.2	Fundamental Concepts	659
15.3	Collective de Broglie Wave	663
15.4	The Penetration Depth	665
15.5	Magnetic Flux Quantization	666
15.6	Type I vs Type II Superconductors	667
15.7	Fluxoid Pinning	672
	REFERENCES	674
	PROBLEMS	675
	EPILOGUE	677
	INDEX	679