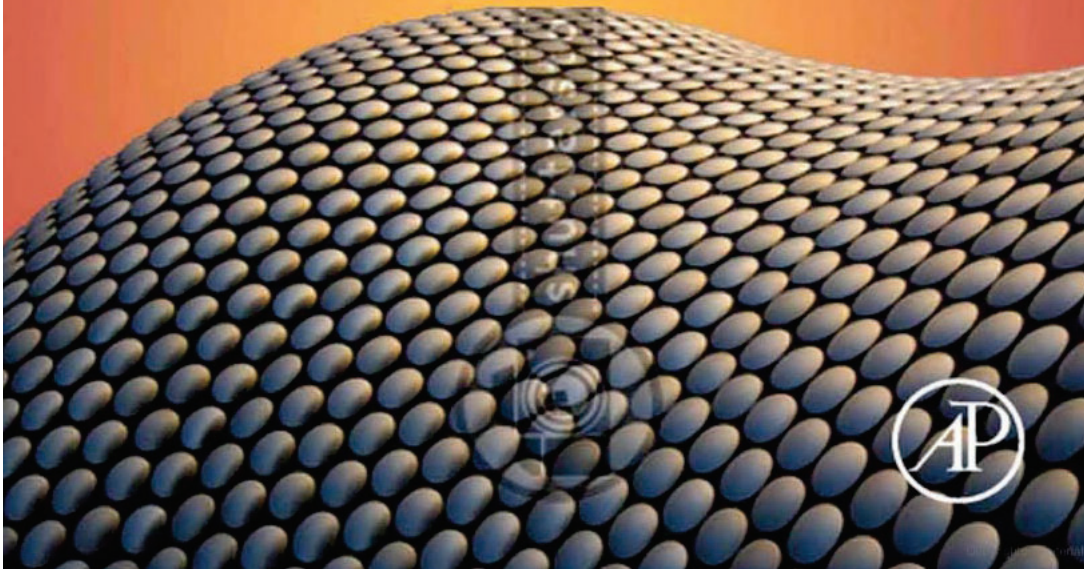


TRAUGOTT FISCHER

Materials Science for Engineering Students



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Traugott Fischer

Stevens Institute of Technology



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Contents

Preface	xiii
PART 1 The Classes of Materials	1
CHAPTER 1 Types of Materials, Electron Energy Bands, and Chemical Bonds	3
1.1 The Classes of Materials	4
1.2 The Structure of Atoms	6
1.3 Atomic and Molecular Orbitals of Electrons	10
1.4 The Electronic Structure of the Solid: Energy Bands and Chemical Bonds	12
1.5 Metals	14
1.6 Ceramics	17
1.7 Polymers and Secondary Bonds	23
1.8 Bond Energy and the Distance Between Atoms	26
1.9 Structural Materials, Functional Materials, and Biomaterials	28
Summary	29
Key Terms	30
PART 2 Structural Materials	35
CHAPTER 2 The Strength of Materials	37
2.1 Stresses and Strains	38
2.2 Elastic Deformation	40
2.3 Plastic Deformation of Metals	41
2.4 Residual Stresses	49
2.5 Hardness	50
2.6 Fracture	52
2.7 The Measurement of Fracture Resistance	59
2.8 Fatigue	64
2.9 Creep	66
Summary	70
Key Terms	71
CHAPTER 3 Deformation of Metals and Crystal Structure	77
3.1 The Plastic Deformation of Metals	78
3.2 The Crystal Structure of Metals	79

3.3	Coordinates of Atomic Positions, Directions, and Planes	87
3.4	Dense Planes and Directions	91
3.5	Defects in Crystalline Solids	91
3.6	Mechanisms of Plastic Deformation	98
	Summary	103
	Key Terms	104
CHAPTER 4	Strengthening and Forming Metals	107
4.1	Strengthening a Metal	108
4.2	Increasing the Ductility by Annealing	115
4.3	Increasing Fracture Resistance	116
4.4	Increasing Fatigue Life	119
4.5	Creep Resistance	120
4.6	Mechanical Forming of Metals	120
4.7	Cutting and Machining	122
	Summary	123
	Key Terms	124
CHAPTER 5	Phase Diagrams	127
5.1	Behavior of Binary Alloys	127
5.2	Phases, Components, and Phase Diagrams	129
5.3	Solid Solutions	129
5.4	Analysis of Binary Phase Diagrams	131
5.5	The Binary Eutectic Phase Diagram	134
5.6	Intermediate Compounds and Intermediate Phases	140
5.7	Peritectic Solidification	141
5.8	The Iron-Carbon System and Steels	143
	Glossary	147
	Summary	148
	Key Terms	149
CHAPTER 6	Reaction Kinetics and the Thermal Processing of Metals	153
6.1	Quenched and Tempered Steel	154
6.2	The Kinetics of Phase Transformations	155
6.3	Thermal Processing of Steel	160
6.4	Heat Treatment of Aluminum Hardening by Precipitation	164
	Summary	167
	Key Terms	168
CHAPTER 7	Metallic Alloys and Their Use	171
7.1	Types of Alloys	172
7.2	Ferrous Alloys	172

7.3	Nonferrous Alloys	177
7.4	Solidification of Metals	186
7.5	Surface Processing of Structural Materials	191
	Summary	202
	Key Terms	204
CHAPTER 8	Ceramics	209
8.1	The Types of Ceramics and Their Defining Properties	210
8.2	Traditional Ceramics	213
8.3	Synthetic High-Performance Ceramics	216
8.4	The Crystal Structures of Ceramics	216
8.5	Glass	227
8.6	Processing of Ceramics	231
8.7	Cement and Concrete	239
	Summary	241
	Key Terms	242
CHAPTER 9	Polymers	247
9.1	Definition of a Polymer	248
9.2	Synthesis of Polymers	249
9.3	Polymers and Secondary Bonds; Thermoplastics	253
9.4	Thermosets	254
9.5	Rubber (Elastomer)	256
9.6	Polymer Structure	257
9.7	Copolymers	260
9.8	Mechanical Behavior of Polymers	263
9.9	Applications of Polymers	268
9.10	Manufacture of Polymeric Objects	271
	Summary	276
	Key Terms	277
CHAPTER 10	Composites	281
10.1	What Are Composites?	282
10.2	Polymer Matrix Composites	282
10.3	Fabricating Polymer Composites	285
10.4	Metal Matrix Composites (MMCs)	288
10.5	Ceramic Matrix Composites	292
10.6	Mechanical Properties of Composites	293
10.7	Concrete	299
10.8	Wood	301
	Summary	304
	Key Terms	305

PART 3	Functional Materials	309
CHAPTER 11	Conductors, Insulators, and Semiconductors	311
11.1	Introduction	312
11.2	Basic Concepts of Electric Conduction	313
11.3	The Density of Mobile Electrons and the Pauli Exclusion Principle	316
11.4	Electron Scattering and the Electric Resistance of Metals	317
11.5	Insulators	321
11.6	Semiconductors	325
	Summary	338
	Key Terms	339
CHAPTER 12	Fabrication of Integrated Circuits and Micro Electro-Mechanical Systems (MEMs)	343
12.1	A Chip and Its Millions of Transistors	344
12.2	Growth of Silicon Single Crystals	345
12.3	Photolithography	347
12.4	Packaging	351
12.5	Oxide Layers	351
12.6	Photoresist	352
12.7	The Mask	352
12.8	Etching	354
12.9	Doping by Ion Implantation	354
12.10	Deposition of Interconnects and Insulating Films	356
12.11	MEMS (Micro Electro-mechanical Systems)	360
	Summary	363
	Key Terms	363
CHAPTER 13	Optical Materials	367
13.1	Uses of Optical Materials	368
13.2	Light and Vision	370
13.3	Interaction of Light with Electrons in Solids	371
13.4	Dielectric Optical Coatings	379
13.5	Electro-Optical Devices	382
13.6	Optical Recording	390
13.7	Optical Communications	391
	Summary	395
	Key Terms	396
CHAPTER 14	Magnetic Materials	401
14.1	Uses of Magnets and the Required Material Properties	402

14.2	Magnetic Fields, Induction, and Magnetization	403
14.3	Ferromagnetic Materials	409
14.4	Properties and Processing of Magnetic Materials	415
14.5	Illustration: Magnetic Recording	418
	Summary	420
	Key Terms	422
CHAPTER 15	Batteries	427
15.1	Batteries	428
15.2	Principles of Electrochemistry	428
15.3	Primary Batteries	438
15.4	Secondary or Rechargeable Batteries	443
15.5	Fuel Cells	448
15.6	Ultracapacitors	450
	Summary	451
	Key Terms	453
PART 4	Environmental Interactions	457
CHAPTER 16	Corrosion and Wear	459
16.1	Some Questions	460
16.2	The Electrochemical Nature of Corrosion in Liquids	460
16.3	Electrode Potentials in Variable Ion Concentrations	464
16.4	Cathodes in Aqueous Corrosion	465
16.5	Faraday's Law—Corrosion Rate	466
16.6	Manifestations of Corrosion	467
16.7	Other Forms of Corrosion	473
16.8	Preventing Corrosion Through Design	475
16.9	Gaseous Oxidation	476
16.10	Wear	480
	Summary	485
	Key Terms	486
CHAPTER 17	Biomaterials	493
17.1	Biomaterials	493
17.2	Metals	496
17.3	Ceramics	498
17.4	Polymers	501
	Summary	508
	Key Terms	509

PART 5	Nanomaterials and the Study of Materials	513
CHAPTER 18	Nanomaterials	515
18.1	The Unique Properties of Nanomaterials	516
18.2	Nanostructured Metals and Composites	518
18.3	Carbon Nanomaterials	518
18.4	Metallic Nanomaterials	521
18.5	Semiconductor Nanoparticles—Quantum Dots	524
18.6	Two-Dimensional Systems	525
18.7	Safety Concerns	528
	Summary	528
	Key Terms	529
CHAPTER 19	The Characterization of Materials	531
19.1	Measuring Chemical Composition: Core Electron Spectroscopy	533
19.2	Determination of the Crystal Structure by Diffraction	538
19.3	Microscopy	546
	Summary	557
	Key Terms	559
	Answers to Selected Problems	563
	Index	569

For glass with $n = 1.5$, $R = 0.5^2/2.5^2 = 0.04$. Thus 4% of the light is reflected from the surface. Even this small amount is an intolerable loss in many optical applications; as we shall see later, it is reduced through the use of antireflection coatings.

Metallic Mirrors Metals have a high index of absorption, and their reflection coefficient can approach 99% according to Equation (13.6). Modern mirrors consist of thin metal films or coatings (typically less than $1\text{ }\mu\text{m}$ thick) deposited on the back of glass substrates. High reflectivity in the visible spectrum is the chief property required of metals for mirror applications, and Figure 13.8 provides such information for the most widely used metals. The absorption coefficients α and k are proportional to the density of electrons capable of acquiring the photon energy $h\nu$. Depending on the details of the electron band structure, the absorption and reflection can vary with the photon energy. Thus, gold and copper (and alloys of these metals) are significantly colored. Aluminum and chromium have a faint bluish, and nickel a weak yellowish, coloration. Most other metals reflect all portions of the visible spectrum and thus appear white.

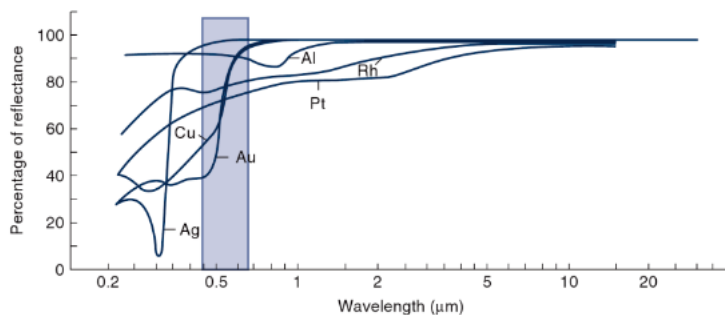
In front-surface mirrors, resistance to mechanical scratching (of Au, Ag, Cu, Al), oxidation (of Al), and tarnishing (of Ag) are additional concerns. Despite its relatively low reflectivity, rhodium, a metal that is more expensive than gold, has found application in telescope mirrors, optical reflectivity standards, and in mirrors for medical purposes. The reason is due to the high hardness and environmental stability of this metal.

EXAMPLE 13.1 (A) The optical constants of silver at a wavelength of $0.55\text{ }\mu\text{m}$ (550 nm) are $n = 0.055$ and $k = 3.32$. What is the reflectance (i.e., fraction of light reflected) of silver at this wavelength? (B) How thin does silver have to be to transmit 50% of the light that is not reflected?

ANSWER (A) Silver is an absorbing material, so Equation (13.6) applies. Substitution yields

$$R = [(0.055 - 1)^2 + 3.32^2] / [(0.055 + 1)^2 + 3.32^2] = 0.982$$

The high reflectivity of silver earmarks its use for mirrors.



■ **FIGURE 13.8** Reflection coefficient of some metals. (Visible range is shaded.)