Introduction to Dislocations Fourth Edition

by D. Hull and D. J. Bacon

Department of Engineering, Materials Science and Engineering, University of Liverpool, UK



OXFORD AUCKLAND BOSTON JOHANNESBURG MELBOURNE NEW DELHI

Contents

		Preface	ix
1	Defects in Crystals	 1.1 Crystalline Materials 1.2 Simple Crystal Structures 1.3 Defects in Crystalline Materials 1.4 Dislocations Further Reading 	1 4 8 14 20
2	Observation of Dislocations	 2.1 Introduction 2.2 Surface Methods 2.3 Decoration Methods 2.4 Electron Microscopy 2.5 X-ray Diffraction Topography 2.6 Field Ion Microscopy 2.7 Computer Simulation Further Reading 	22 22 26 27 35 36 38 41
3	Movement of Dislocations	 3.1 Concept of Slip 3.2 Dislocations and Slip 3.3 The Slip Plane 3.4 Cross Slip 3.5 Velocity of Dislocations 3.6 Climb 3.7 Experimental Observation of Climb 3.8 Conservative Climb 3.9 Plastic Strain due to Dislocation Movement Further Reading 	42 44 45 48 49 52 55 57 57 60
4	Elastic Properties of Dislocations	 4.1 Introduction 4.2 Elements of Elasticity Theory 4.3 Stress Field of a Straight Dislocation 4.4 Strain Energy of a Dislocation 4.5 Forces on Dislocations 4.6 Forces between Dislocations 4.7 Climb Forces 4.8 Image Forces Further Reading 	62 62 65 69 72 74 78 79 80

5	Dislocations in Face-centred Cubic Metals	 5.1 Perfect Dislocations 5.2 Partial Dislocations – the Shockley Partial 5.3 Slip 5.4 Thompson's Tetrahedron 5.5 Frank Partial Dislocation 5.6 Lomer-Cottrell Sessile Dislocation 5.7 Stacking Fault Tetrahedra Further Reading 	82 82 84 91 92 97 98 101
6	Dislocations in Other Crystal Structures	 6.1 Introduction 6.2 Dislocations in Hexagonal Close-packed Metals 6.3 Dislocations in Body-centred Cubic Metals 6.4 Dislocations in Ionic Crystals 6.5 Dislocations in Superlattices 6.6 Dislocations in Covalent Crystals 6.7 Dislocations in Layer Structures 6.8 Dislocations in Polymer Crystals Further Reading 	102 102 110 114 117 122 124 126 126
7	Jogs and the Intersection of Dislocations	 7.1 Introduction 7.2 Intersection of Dislocations 7.3 Movement of Dislocations Containing Elementary Jogs 7.4 Superjogs 7.5 Jogs and Prismatic Loops 7.6 Intersections of Extended Dislocations and Extended Jogs 7.7 Attractive and Repulsive Junctions 7.8 Extended Stacking-fault Nodes Further Reading 	128 129 130 133 136 137 139 142 144
8	Origin and Multiplication of Dislocations	 8.1 Introduction 8.2 Dislocations in Freshly Grown Crystals 8.3 Homogeneous Nucleation of Dislocations 8.4 Nucleation of Dislocations at Stress Concentrators 8.5 Multiplication of Dislocations by Frank-Read Sources 8.6 Multiplication by Multiple Cross Glide 8.7 Multiplication by Climb 8.8 Grain Boundary Sources Further Reading 	145 145 147 148 150 151 153 155 156
9	Dislocation Arrays and Crystal Boundaries	 9.1 Plastic Deformation, Recovery and Recrystallisation 9.2 Simple Dislocation Boundaries 9.3 General Low-angle Boundaries 9.4 Stress Field of Dislocation Arrays 	157 161 163 168

		9.5	Strain Energy of Dislocation Arrays	172
		9.6	Dislocations and Steps in Interfaces	173
		9.7	Movement of Boundaries	181
		9.8	Dislocation Pile-ups	190
		Further Reading		192
10	Strength of Crystalline	10.1	Introduction	193
	Solids	10.2	Temperature- and Strain-rate-dependence of the	
			Flow Stress	195
		10.3	The Peierls Stress and Lattice Resistance	197
		10.4	Interaction Between Point Defects and Dislocations	202
		10.5	Solute Atmospheres and Yield Phenomena	206
		10.6	The Flow Stress for Random Arrays of Obstacles	215
		10.7	The Strength of Alloys	219
		10.0	Wash Handon's a	224

10.7	The Strength of Alloys	219
10.8	Work Hardening	224
10.9	Deformation of Polycrystals	229
10.10	Dislocations and Fracture	232
Furthe	r Reading	235

The SI System of Units	237
Index	239