

# Contents

<i>List of Contributors</i>	xiii
<i>Society of Dyers and Colourists</i>	xv
<i>Preface</i>	xvii
<b>1 The Structure of Wool</b>	<b>1</b>
<i>John A. Rippon</i>	
1.1 Introduction	1
1.2 Composition of Wool	2
1.3 Chemical Structure of Wool	5
1.3.1 General Chemical Structure of Proteins	5
1.3.2 Amino Acid Composition of Wool	6
1.3.3 Arrangement of Amino Acids in Wool	8
1.3.4 The Structure of Wool Proteins	11
1.3.5 Wool Lipids	13
1.4 Morphological Structure of Wool	14
1.4.1 The Cuticle and the Fibre Surface	16
1.4.2 The Cortex	23
1.4.3 The Cell Membrane Complex	27
1.5 Chemical Reactivity of Wool	32
1.6 Damage in Wool Dyeing	32
1.6.1 Nonkeratinous Proteins and Damage in Dyeing	33
1.6.2 Influence of Dyebath pH on Fibre Damage	34
1.7 Conclusion	35
References	35
<b>2 The Chemical and Physical Basis for Wool Dyeing</b>	<b>43</b>
<i>John A. Rippon</i>	
2.1 Introduction	43
2.2 The Chemical Basis for Wool Dyeing	43
2.2.1 The Wool–Water System	44
2.2.2 The Amphoteric Nature of Wool and Dyeing Behaviour	44
2.2.3 Classical Theories of Wool Dyeing	46
2.2.4 Modern Theories of Wool Dyeing	49
2.3 Standard Affinity and Heat of Dyeing	50

2.4	Classification of Dyes Used for Wool	52
2.5	Dye Aggregation	55
2.6	The Physical Basis for Wool Dyeing: The Role of Fibre Structure	60
2.6.1	Diffusion of Dyes	60
2.6.2	Pathways of Dye Diffusion into Wool	61
2.7	Effect of Chemical Modifications on Dyeing	66
2.7.1	Chlorination	66
2.7.2	Plasma Treatment	67
2.7.3	Differential Dyeing	68
2.8	Conclusion	68
	References	69
<b>3</b>	<b>The Role of Auxiliaries in the Dyeing of Wool and other Keratin Fibres</b>	<b>75</b>
	<i>Arthur C. Welham</i>	
3.1	Introduction	75
3.2	Surface Activity of Wool-Dyeing Auxiliaries	76
3.2.1	Anionic Auxiliaries	76
3.2.2	Cationic Auxiliaries	77
3.2.3	Ethoxylated Nonionic and Cationic Auxiliaries	78
3.2.4	Amphoteric Auxiliaries	80
3.2.5	Other Auxiliaries	81
3.3	Brightening Agents	81
3.4	Levelling Agents	82
3.4.1	Material Faults	83
3.4.2	Dyeing and Processing Faults	83
3.4.3	Testing the Action of Levelling Agents	85
3.4.4	Product Selection	86
3.4.5	Coverage of Skittery or Tippy-Dyeing Wool	86
3.5	Restraining and Reserving Agents in Wool Blend Dyeing	88
3.6	Antiprecipitants	89
3.7	Wool Protective Agents	89
3.8	Low-Temperature Dyeing	90
3.9	Correction of Faulty Dyeings	92
3.10	Aftertreatments to Improve Wet Fastness	93
3.11	Effluent Control in Chrome Dyeing	94
3.12	Antifrosting Agents	95
3.13	Antisetting Agents	95
3.14	Sequestering Agents	96
3.15	Conclusions	96
	References	97
<b>4</b>	<b>Ancillary Processes in Wool Dyeing</b>	<b>99</b>
	<i>David M. Lewis</i>	
4.1	Introduction	99
4.2	Wool Scouring	99

4.3	Wool Carbonising	100
4.4	Shrink-Resist Treatments	102
4.4.1	Top Shrink-Resist Processes	102
4.4.2	Garment Shrink-Resist Treatments	105
4.4.3	Fabric Shrink-Resist Treatments	106
4.4.4	Miscellaneous Developments	107
4.4.5	Colour-Fastness Requirements for Machine-Washable Wool	108
4.5	Insect-Resist Treatments	108
4.5.1	Insect Pests	108
4.5.2	Insect-Resist Agents	109
4.5.3	Application Methods for IR Agents	113
4.6	Flame-Retardant Treatments	115
4.7	Antisetting Agents	116
4.7.1	The Role of Oxidants in Preventing Setting in Dyeing	118
4.7.2	The Role of Electrophilic Reagents in Controlling Setting in Dyeing	119
4.8	Fibre Arylating Agents (FAA)	120
	References	126
<b>5</b>	<b>Bleaching and Whitening of Wool: Photostability of Whites</b>	<b>131</b>
	<i>Keith R. Millington</i>	
5.1	Introduction	131
5.2	Wool Colour	132
5.2.1	Measuring Wool Colour	132
5.2.2	Improving Wool Colour by Selection	134
5.2.3	Improving Colour in the Scour	134
5.2.4	Nonscourable Yellowing	135
5.2.5	Wool Colour Compared with Cotton and Synthetics	135
5.3	Wool Bleaching	138
5.3.1	Oxidative Bleaching	138
5.3.2	Reductive Bleaching	139
5.3.3	Double (or Full) Bleaching	140
5.3.4	Bleaching of Pigmented Wools	140
5.3.5	Bleaching in the Dyebath	140
5.3.6	Biobleaching of Wool Using Enzymes	142
5.3.7	Activated Peroxide Bleaching	143
5.3.8	Catalytic Peroxide Bleaching	144
5.3.9	Novel Bleaching Methods for Wool	144
5.4	Fluorescent Whitening of Wool	144
5.5	Photostability of Wool	145
5.5.1	Mechanism of Wool Photoyellowing	148
5.5.2	Mechanism of Photoyellowing of Fluorescent Whitened Wool	149
5.5.3	Methods for Improving Photostability	151
	References	153

<b>6</b>	<b>Wool-dyeing Machinery</b>	<b>157</b>
	<i>Jamie A. Hawkes and Paul Hamilton</i>	
6.1	Introduction	157
6.2	Top Dyeing	158
6.2.1	Longclose (UK) Large Bump Tops	160
6.2.2	Obem Big Form	161
6.2.3	Vigoreux Printing	161
6.3	Loose Stock Dyeing	162
6.3.1	Continuous Dyeing of Loose Stock	165
6.4	Hank-Dyeing Yarn	166
6.4.1	Carpet Yarn	166
6.4.2	Hand-Knitting and Machine-Knitting Yarn	167
6.4.3	Robotic Handling	169
6.4.4	Space Dyeing of Yarn	169
6.5	Yarn Package Dyeing	171
6.5.1	Package Preparation	172
6.5.2	Machinery	175
6.6	Piece Dyeing	178
6.6.1	Jet and Overflow Dyeing	178
6.6.2	Beam Dyeing	179
6.7	Garment Dyeing	179
6.8	Carpet Piece Dyeing	182
6.9	Drying	183
6.9.1	Mechanical Moisture Removal	183
6.9.2	Thermal Moisture Removal	184
6.10	Dyehouse Automation	186
6.10.1	Dyehouse Control Systems	186
6.10.2	Factory Management Systems	188
6.10.3	Process Control	188
6.10.4	Effluent Control Systems	190
6.10.5	Colour Measurement	191
6.11	Laboratory Dyeing	192
6.11.1	Tops, Loose Stock, Hanks and Package Yarn	193
6.11.2	Piece Dyeing	198
6.11.3	Garment Dyeing	201
6.11.4	Laboratory Machine Control Systems	202
	References	203
<b>7</b>	<b>Dyeing Wool with Acid and Mordant Dyes</b>	<b>205</b>
	<i>Peter A. Duffield</i>	
7.1	Introduction	205
7.2	Acid Dyes	208
7.2.1	Acid Dye Subclassification	208
7.2.2	Optimised Dye Ranges	213
7.3	Natural Dyes	213

7.4	Mordant Dyes	214
7.4.1	Chrome Dyeing Processes	216
7.4.2	Theoretical Aspects	219
7.4.3	Low-Chrome Dyeing	223
7.5	Specific Dyeing Methods	226
	References	227
<b>8</b>	<b>Dyeing Wool with Metal-complex Dyes</b>	<b>229</b>
	<i>Stephen M. Burkinshaw</i>	
8.1	Introduction	229
8.2	Dye Structure	230
8.2.1	Electronic Structure	232
8.2.2	Colour and Light Fastness	235
8.2.3	Stereochemistry and Isomerism	236
8.2.4	1 : 1 Metal-Complex Dyes	237
8.2.5	1 : 2 Metal-Complex Dyes	239
8.3	Dye Application	242
8.3.1	1 : 1 Metal-Complex Dyes	242
8.3.2	1 : 2 Metal-Complex Dyes	246
8.4	Environmental Aspects	248
	References	248
<b>9</b>	<b>Dyeing Wool with Reactive Dyes</b>	<b>251</b>
	<i>David M. Lewis</i>	
9.1	Introduction	251
9.2	Commercial Reactive Dyes for Wool	252
9.3	The Chemistry of Reactive Dyes	253
9.3.1	Nucleophilic Substitution Reactions	253
9.3.2	Michael Addition Reaction	253
9.3.3	Specific Reactive Dyes for Wool	254
9.4	Application Procedures	260
9.4.1	Auxiliary Agents	260
9.4.2	Dyeing Processes Used with Reactive Dyes	261
9.4.3	Effect of Reactive Dyes on Fibre Properties	276
9.5	Novel Reactive Dye Systems for Wool	281
9.5.1	Maleinimides	281
9.5.2	Isocyanate and Isothiocyanate Bisulphite Adducts	281
9.5.3	Carboxymethyl Carbodithioate Dyes	282
9.5.4	Trifunctional Reactive Dyes Prepared from Bis-(chloroethyl-sulphonylethyl)amine [P-3] Reaction with a DCT Dye	282
9.5.5	Crosslinking Agents to Covalently Fix Acid Dyes to Wool	283
9.6	Identification of the Reaction Sites in the Fibre	285
9.7	Conclusions	287
	References	287

<b>10 Dyeing Wool Blends</b>	<b>291</b>
<i>David M. Lewis</i>	
10.1 Introduction	291
10.2 Wool/Cotton	293
10.2.1 Dyeing of Cotton	293
10.2.2 Exhaustion Dyeing of Wool/Cotton Blends	296
10.2.3 Pad Dyeing of Wool/Cotton Blends	300
10.2.4 Wool Damage during Dyeing	301
10.3 Amination of Cellulosic Fibres	303
10.4 Wool/Silk	305
10.4.1 Dyeing of Silk	306
10.4.2 Dyeing of Wool/Silk Blends	308
10.5 Wool/Nylon	310
10.5.1 Dyeing of Nylon	310
10.5.2 Dyeing of Wool/Nylon Blends	319
10.6 Wool/Polyester	323
10.6.1 Dyeing of Polyester	323
10.6.2 Dyeing of Wool/Polyester Blends	333
10.7 Wool/Acrylic	341
10.7.1 Dyeing of Acrylic Fibres	342
10.7.2 Dyeing of Wool/Acrylic Blends	348
10.8 Conclusions	351
References	352
<b>11 The Coloration of Human Hair</b>	<b>357</b>
<i>Robert M. Christie and Olivier J.X. Morel</i>	
11.1 Introduction	357
11.2 Structure and Morphology of Human Hair	359
11.3 Natural Colour of Hair	360
11.4 Physical Chemistry of Hair Dyeing	364
11.5 Toxicology of Hair Dyes	365
11.6 Oxidative Hair Coloration	366
11.7 Alternative Approaches to Permanent Hair Dyeing	369
11.8 Nonoxidative Hair Dyeing	375
11.9 Conclusion	386
References	387
<b>12 Wool Printing</b>	<b>393</b>
<i>Peter J. Broadbent and Muriel L.A. Rigout</i>	
12.1 Introduction	393
12.2 Preparation for Printing	394
12.2.1 Oxidative Processes	394
12.2.2 Polymer Treatments	396
12.2.3 Plasma Treatments	397
12.2.4 Other Methods of Preparation for Printing	398

12.3	Direct Printing	399
12.3.1	Machinery	399
12.3.2	Dye Selection and Print Recipes	399
12.3.3	Steaming	402
12.3.4	Washing and Aftertreatment	404
12.4	Discharge Printing	405
12.4.1	Ground Shades	405
12.4.2	Discharge Agents	405
12.4.3	Illuminating Dyes	407
12.4.4	Printing and Fixation	407
12.5	Resist Printing	408
12.5.1	Chemical Resist Processes	409
12.5.2	Mechanical/Chemical Resist Processes	411
12.5.3	Reactive-Under-Reactive Resist	412
12.6	Digital Printing	412
12.6.1	Machinery	413
12.6.2	Ink Formulation	413
12.6.3	Fabric Pretreatment	415
12.6.4	Fixation	417
12.6.5	Wash-Off	417
12.7	Wool Blends	418
12.7.1	Wool/Polyester	419
12.7.2	Wool/Cotton	419
12.7.3	Wool/Acrylic	420
12.8	Cold Print Batch	420
12.9	Transfer Printing	421
12.9.1	Wet or 'Migration' Transfer Printing	421
12.9.2	Sublimation Transfer Printing	422
12.9.3	Benzoylated Wool	424
12.10	Novel Effects	425
12.10.1	Burn-Out ( <i>devorée</i> ) Printing	425
12.10.2	Sculptured Effects	425
	References	426
	<b>Index</b>	<b>431</b>