

Contents

	Disclaimer	IV
	Preface	V
1	Introduction <i>Herman Dikland and Martin van Duin</i>	1
	1. Relevance of the rubber industry	1
	2. ARLANXEO: one of the world's largest producers of synthetic rubber	5
	3. Concept and purpose of this book	6
	4. Structure of the book	7
2	A historic perspective of ARLANXEO in the synthetic rubber industry <i>Thomas Früh and Klaus Zander</i>	11
	1. The origin and legacy of ARLANXEO	11
	2. Rubbers – originating from nature and transforming our lives today beyond recognition	12
	3. Concluding remarks	24
3	Health, safety, environment, and quality of rubber <i>Petra Knape, Bernd Hoppe, Rüdiger Engehausen, Stefan Neumann, and Hans-Jürgen Mick</i>	27
	1. Occupational health and safety	27
	2. Process safety	29
	3. Regulatory affairs and product safety	29
	4. Environment and sustainability	30
	5. Quality management	31
4	Rubber structure/properties relationships <i>Martin van Duin</i>	35
	1. Introduction	35
	2. Rubber definition and description	37
	3. Rubber structure/properties relationships	40
	4. Molar mass (distribution) and long-chain branching	61
5	Polymerisation chemistry and process technology of synthetic rubber <i>Ronald Huyps, Andreas Kaiser, and Susanna Lieber</i>	67
	1. Polymers	67
	2. Principles of polymerisation	69
	3. Polymerisation mechanisms	72
	4. Production technology	77
	5. Process challenges in industrial rubber production processes	80

CONTENTS

6	Rubber analysis and testing	89
	<i>Thomas Pesch and Jie Mao</i>	
	1. Introduction	89
	2. Rubber analysis	89
	3. Rubber testing	98
7	Rubber compounding and processing	111
	<i>Andreas Bischoff and Saeid Kheirandish</i>	
	1. Introduction	111
	2. Compound formulation and ingredients	112
	3. Compound development	128
	4. Rubber processing	132
	5. Mixing	135
	6. Calendering and extrusion	144
	7. Vulcanisation	146
8	Emulsion styrene-butadiene rubber: Buna® SE and Taktene® E-SBR	151
	<i>Marcus Moutinho, Manoel Remígio, Frederico Gomes, Fábio Aquino, Jeferson Kranz, and Luiz Nicolini</i>	
	1. Introduction	151
	2. Manufacturing	152
	3. Structure/properties relationships	157
	4. Product portfolio	159
	5. Rubber compounding	161
	6. Rubber applications and starting compound formulations	163
	7. Latex applications	166
9	Solution styrene-butadiene rubber: Buna® SL, VSL, BL, and FX S-SBR	173
	<i>Norbert Steinhauser and Jiawen Zhou</i>	
	1. Introduction	173
	2. Manufacturing	174
	3. Structure/properties relationships	178
	4. Product portfolio	179
	5. Compounding	182
	6. Mixing, processing, and vulcanisation	186
	7. Tyre applications and starting compound formulations	187
10	Butadiene rubber: Buna® CB and Nd EZ BR	195
	<i>Kim-Julia Kurth, Kilian Wüst, Jiawen Zhou, Kevin Kulbaba, and Thomas Rünzi</i>	
	1. Introduction	195
	2. Manufacturing	195
	3. Structure/properties relationships	202
	4. Product portfolio	204
	5. Compounding	206

6. Mixing, processing, and vulcanisation	207
7. Applications and starting compound formulations	208
8. Future outlook	215
11 Butyl rubber: X_Butyl® (X)IIR	219
<i>Greg Davidson, Rayner Krista, and Dana Adkinson</i>	
1. Introduction	219
2. Manufacturing	220
3. Structure/properties relationships	223
4. Product portfolio	224
5. Compounding	224
6. Mixing, processing, and vulcanisation	228
7. Applications and starting compound formulations	230
12 Ethylene-propylene-diene rubber: Keltan® EPDM	239
<i>Martin van Duin and Philip Hough</i>	
1. Introduction	239
2. Manufacturing	240
3. Structure/properties relationships	242
4. Product portfolio	244
5. Compounding	247
6. Mixing, processing, and vulcanisation	254
7. Applications and starting compound formulations	256
13 Nitrile rubber: Perbunan®, Krynac®, and Baymod® N NBR	267
<i>Björn Loges and Robert Stäber</i>	
1. Introduction	267
2. Manufacturing	268
3. Structure/properties relationships	271
4. Product portfolio	274
5. Compounding	277
6. Mixing, processing, and vulcanisation	285
7. Applications and starting compound formulations	287
14 Hydrogenated nitrile rubber: Therban® HNBR	295
<i>Sarah David, Marjan Hemstede - van Urk, Andreas Kaiser, and Karola Schneiders</i>	
1. Introduction	295
2. Manufacturing	296
3. Structure/properties relationships	299
4. Product portfolio	301
5. Compounding	304
6. Mixing, processing, and vulcanisation	313
7. Applications and starting compound formulations	314

CONTENTS

15	Chloroprene rubber: Baypren® CR	319
	<i>Nicolas Sary, Frank Taschner, Victor Nasreddine, and Hadis Kühl</i>	
	1. Introduction	319
	2. Manufacturing	319
	3. Structure/properties relationships	323
	4. Product portfolio	324
	5. Compounding	325
	6. Mixing, processing, and vulcanisation	333
	7. Applications and starting compound formulations	337
	8. Concluding remarks	342
16	Ethylene-vinyl acetate rubber: Levapren® EVM	345
	<i>Martin Hoch and Rainer Kalkofen</i>	
	1. Introduction	345
	2. Manufacturing	345
	3. Structure/properties relationships	347
	4. Product portfolio	351
	5. Compounding	351
	6. Mixing, processing, and vulcanisation	356
	7. Vulcanisate properties	358
	8. Flame-retardant compounding	361
	9. Applications and starting compound formulations	363
17	What next for the rubber industry?	367
	<i>Niels van der Aar, Thomas Früh, Thomas Groß, Martin van Duin, and Heiner Stange</i>	
	1. Megatrends in society	367
	2. Future rubber value chain	369
	3. Biobased feedstock	370
	4. Energy efficiency at all levels of the rubber value chain	373
	5. Rubber applications for improved sustainability	375
	6. Closing the loop: rubber recycling	386
	7. Concluding remarks	389
	Postface	393
	Appendix 1: Medium resistance of rubbers	394
	Appendix 2: Details for Section 3.3. “Application examples” in Chapter 7. “Rubber compounding and processing”	400
	Abbreviations	402
	Subject index	406