

Smart fibres, fabrics and clothing

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The history of textiles and fibres spans thousands of years, beginning with the style change from animal skins to the first fabric used to clothe humanity. But during the relatively short period of the past 50 years, the fibre and textile industries have undergone the most revolutionary changes and seen the most remarkable innovations in their history. Chapter One discusses the most important innovations together with the advent of the information industry. In fact, it is the merger of these industries that has led to this book.

We are not talking merely of fabrics and textiles imparting information; indeed, that has been occurring for many, many generations and numerous examples exist from fabrics and tapestries that have told intricate tales of warfare and family life and history, to those imparting information about the wealth and social status of the owners of the fabrics. We are talking about much more. Nor are we referring to fabrics that may have multifunctional purposes, such as fashion and environmental protection, or rainwear, or those fabrics providing resistance to a plethora of threats, such as ballistic, chemical and flame protection. These systems are all passive systems. No, we are talking here about materials or structures that sense and react to environmental stimuli, such as those from mechanical, thermal, chemical, magnetic or others. We are talking ‘smart’ and ‘active’ systems. We are talking about the true merger of the textile and information industries.

‘Smart textiles’ are made possible due to advances in many technologies coupled with the advances in textile materials and structures. A partial list includes biotechnology, information technology, microelectronics, wearable computers, nanotechnology and microelectromechanical machines.

Many of the innovations in textile applications in the past 50 years have started with military applications – from fibreglass structures for radomes, to fragment and bullet resistant body armour, to chemical agent protective clothing, to fibre-reinforced composites – indeed, many of our current defence systems and advanced aircraft would not be possible without these materials. So perhaps it is not surprising that the initial applications for smart textiles have also come either directly from military R&D or from spin-offs. Some of

the capabilities for smart textile systems for military applications are: sensing and responding, for example to a biological or chemical sensor; power and data transmission from wearable computers and polymeric batteries; transmitting and receiving RF signals; automatic voice warning systems as to 'dangers ahead'; 'on-call' latent reactants such as biocides or catalytic decontamination *in-situ* for chemical and biological agents; and self-repairing materials.

In many cases the purpose of these systems is to provide both military and civilian personnel engaged in high-risk applications with the most effective survivability technologies. They will thus be able to have superiority in fightability, mobility, cognitive performance, and protection through materials for combat clothing and equipment, which perform with intelligent reaction to threats and situational needs. Thus, we will be providing high-risk personnel with as many executable functions as possible, which require the fewest possible actions on his/her part to initiate a response to a situational need. This can be accomplished by converting traditional passive clothing and equipment materials and systems into active systems that increase situational awareness, communications, information technology, and generally improve performance.

Some examples of these systems are body conformal antennas for integrated radio equipment into clothing; power and data transmission – a personal area network; flexible photovoltaics integrated into textile fabrics; physiological status monitoring to monitor hydration and nutritional status as well as the more conventional heart monitoring; smart footwear to let you know where you are and to convert and conserve energy; and, of course, phase change materials for heating and cooling of the individual. Another application is the weaving of sensors into parachutes to avoid obstacles and steer the parachutist or the cargo load to precise locations.

There are, naturally, many more applications for 'smart' textiles than those applied to military personnel, or civilian police, firemen, and emergency responders. Mountain climbers, sports personnel, businessmen with built-in wearable microcomputers, and medical personnel will all benefit from this revolution in textiles.

You will learn of many more applications for 'smart' textiles in this book. You will find that the applications are limited only by your imagination and the practical applications perhaps limited only by their cost. But we know those costs will come down. So let your imagination soar. The current worldwide textile industry is over 50 million metric tons per year, and if we are able to capture only a measly 1% of that market, it is still worth more than £1 billion.

Dr Robert W. Lewis

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	<i>Foreword</i>	xi
	<i>List of contributors</i>	xiii
	<i>Acknowledgements</i>	xvii
1	Smart technology for textiles and clothing – introduction and overview	1
	XIAOMING TAO	
1.1	Introduction	1
1.2	Development of smart technology for textiles and clothing	3
1.3	Outline of the book	5
2	Electrically active polymer materials – application of non-ionic polymer gel and elastomers for artificial muscles	7
	TOSHIHIRO HIRAI, JIANMING ZHENG, MASASHI WATANABE AND HIROFUSA SHIRAI	
2.1	Introduction	7
2.2	Polymer materials as actuators or artificial muscle	9
2.3	Peculiarity of polymer gel actuator	10
2.4	Triggers for actuating polymer gels	10
2.5	Electro-active polymer gels as artificial muscles	15
2.6	From electro-active polymer gel to electro-active elastomer with large deformation	28
2.7	Conclusions	30
	Acknowledgements	30
	References	30

vi	Contents	
3	Heat-storage and thermo-regulated textiles and clothing	34
	XINGXIANG ZHANG	
3.1	Development introduction	34
3.2	Basics of heat-storage materials	35
3.3	Manufacture of heat-storage and thermo-regulated textiles and clothing	41
3.4	Properties of heat-storage and thermo-regulated textiles and clothing	47
3.5	Application	52
3.6	Development trends	54
	References	55
4	Thermally sensitive materials	58
	PUSHPA BAJAJ	
4.1	Introduction	58
4.2	Thermal storage and thermal insulating fibres	60
4.3	Thermal insulation through polymeric coatings	68
4.4	Designing of fabric assemblies	75
	References	79
5	Cross-linked polyol fibrous substrates as multifunctional and multi-use intelligent materials	83
	TYRONE L. VIGO AND DEVRON P. THIBODEAUX	
5.1	Introduction	83
5.2	Fibrous intelligent materials	83
5.3	Experimental	85
5.4	Results and discussion	86
5.5	Conclusions	91
	References	92
6	Stimuli-responsive interpenetrating polymer network hydrogels composed of poly(vinyl alcohol) and poly(acrylic acid)	93
	YOUNG MOO LEE AND SO YEON KIM	
6.1	Introduction	93
6.2	Experimental	95
6.3	Results and discussion	97
6.4	Conclusions	106
	References	107

7	Permeation control through stimuli-responsive polymer membrane prepared by plasma and radiation grafting techniques	109
	YOUNG MOO LEE AND JIN KIE SHIM	
7.1	Introduction	109
7.2	Experimental	110
7.3	Results and discussion	112
7.4	Conclusions	121
	Acknowledgement	122
	References	122
8	Mechanical properties of fibre Bragg gratings	124
	XIAOGENG TIAN AND XIAOMING TAO	
8.1	Introduction	124
8.2	Fabrication techniques	125
8.3	Mechanisms of FBG sensor fabrication	127
8.4	Mechanical properties	130
8.5	Influence of the UV irradiation on mechanical properties	133
8.6	Polymeric fibre	141
8.7	Conclusions	145
	Acknowledgements	145
	References	145
9	Optical responses of FBG sensors under deformations	150
	DONGXIAO YANG, XIAOMING TAO AND APING ZHANG	
9.1	Introduction	150
9.2	Optical methodology for FBG sensors	151
9.3	Optical responses under tension	156
9.4	Optical responses under torsion	158
9.5	Optical responses under lateral compression	161
9.6	Optical responses under bending	165
9.7	Conclusions	166
	Acknowledgements	167
	References	167
10	Smart textile composites integrated with fibre optic sensors	174
	XIAOMING TAO	
10.1	Introduction	174

viii	Contents	
10.2	Optical fibres and fibre optic sensors	175
10.3	Principal analysis of embedded fibre Bragg grating sensors	177
10.4	Simultaneous measurements of strain and temperature	181
10.5	Measurement effectiveness	187
10.6	Reliability of FBGs	191
10.7	Error of strain measurement due to deviation of position and direction	192
10.8	Distributed measurement systems	195
10.9	Conclusions	195
	Acknowledgements	197
	References	197
11	Hollow fibre membranes for gas separation	200
	PHILIP J. BROWN	
11.1	Historical overview of membranes for gas separation	200
11.2	Development of membranes for industrial gas separation	202
11.3	Theories of permeation processes	211
11.4	Phase inversion and hollow fibre membrane formation	211
11.5	Future hollow fibre membranes and industrial gas separation	214
	References	215
12	Embroidery and smart textiles	218
	BÄRBEL SELM, BERNHARD BISCHOFF AND ROLAND SEIDL	
12.1	Introduction	218
12.2	Basics of embroidery technology	218
12.3	Embroidery for technical applications – tailored fibre placement	220
12.4	Embroidery technology used for medical textiles	221
12.5	Embroidered stamp – gag or innovation?	224
12.6	Summary	225
	References	225
13	Adaptive and responsive textile structures (ARTS)	226
	SUNG MEE PARK AND SUNDARESAN JAYARAMAN	
13.1	Introduction	226
13.2	Textiles in computing: the symbiotic relationship	226
13.3	The Georgia Tech Wearable Motherboard™	228
13.4	GTWM: contributions and potential applications	236
13.5	Emergence of a new paradigm: harnessing the opportunity	240
13.6	Conclusion	244
	Acknowledgements	245
	References	245

14	Wearable technology for snow clothing	246
	HEIKKI MATTILA	
14.1	Introduction	246
14.2	Key issues and performance requirements	247
14.3	The prototype	248
14.4	Conclusions	252
15	Bioprocessing for smart textiles and clothing	254
	ELISABETH HEINE AND HARTWIG HOECKER	
15.1	Introduction	254
15.2	Treatment of wool with enzymes	256
15.3	Treatment of cotton with enzymes	263
15.4	Enzymatic modification of synthetic fibres	270
15.5	Spider silk	270
15.6	'Intelligent' fibres	271
15.7	Conclusions	271
	Acknowledgements	272
	References	272
16	Tailor-made intelligent polymers for biomedical applications	278
	ANDREAS LENDLEIN	
16.1	Introduction	278
16.2	Fundamental aspects of shape memory materials	280
16.3	Concept of biodegradable shape memory polymers	281
16.4	Degradable thermoplastic elastomers having shape memory properties	284
16.5	Degradable polymer networks having shape memory properties	287
16.6	Conclusion and outlook	288
	Acknowledgements	288
	References	288
17	Textile scaffolds in tissue engineering	291
	SEERAM RAMAKRISHNA	
17.1	Introduction	291
17.2	Ideal scaffold system	295
17.3	Scaffold materials	296
17.4	Textile scaffolds	298
17.5	Conclusions	306
	Acknowledgements	306
	References	306
	<i>Index</i>	315