Smart fibres, fabrics and clothing

Edited by

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Foreword

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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