

Introduction

There are two ways to study intelligent materials – the more traditional top-down approach, starting often with available macroscopic materials, and the bottom-up approach, starting from molecules or their assemblies. The first approach is mostly in the hands of engineers and physicists, the second one more in the hands of chemists. The present monograph tries to bridge a gap between these communities, with the aim of a better understanding the almost unlimited opportunities with new smart materials, also for students interested in this necessarily highly interdisciplinary field. Leading experts contributing to this book will illustrate the fundamentals and the present stage of a field, which extends over many areas of science and technology. Difficult and painful decisions were necessary in order to restrict the volume of this book to a manageable size, and to avoid too much overlap with already existing monographs. Certain areas such as liquid crystals, or piezoelectric materials, which are already very much developed, and for which excellent books are available, were deliberately confined to more recent developments, such as the use of liquid-crystal elastomers for actuators. We define intelligent materials as those that are multifunctional due to their unique molecular structure and respond to external stimuli by a characteristic behaviour to the outside world. Thus, we also can restrict the volume to fundamental events, which then can be the basis for new technologies. In this sense, technical devices, which are engineered on the basis of intelligent materials, are not emphasised within this book.

It is hoped that a condensed outline of the essentials of intelligent materials will open the doors also for newcomers to a field that experiences a very rapid development in quite different directions, and holds promise for many possible applications. These involve fields such as medicine, nanoscience and nanotechnology, engineering, biotechnology, pharmaceutical, and food industries, process control, agriculture, as well as new communication and memory devices. Many of such systems are biomimetic, and can be looked at as first steps to make intelligent use of principles invented by nature over billions of years of evolution. At the same time, such smart materials can greatly contribute to improve or repair functions and communication in complex biological systems. We sincerely hope that this book will be a valuable addition to the field of smart/intelligent materials and their applications.

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