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Conjugated Conducting Polymers

With 118 Figures

With Contributions by
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Preface

This book reviews the current understanding of electronic, optical and magnetic properties of conjugated polymers in both the semiconducting and metallic states. It introduces in particular novel phenomena and concepts in these quasi-one-dimensional materials that differ from the well-established concepts valid for crystalline semiconductors.

After a brief introductory chapter, the second chapter presents basic theoretical concepts and treats in detail the various models for π-conjugated polymers and the computational methods required to derive observable quantities. Specific spatially localized structures, often referred to as solitons, polarons and bipolarons, result naturally from the interaction between π-electrons and lattice displacements. For a semi-quantitative understanding of the various measurements, electron–electron interactions have to be incorporated in the models; this in turn makes the calculations rather complicated. The third chapter is devoted to the electrical properties of these materials. The high metallic conductivity achieved by doping gave rise to the expression *conducting polymers*, which is often used for such materials even when they are in their semiconducting or insulating state. Although conductivity is one of the most important features, the reader will learn how difficult it is to draw definite conclusions about the nature of the charge carriers and the microscopic transport mechanism solely from electrical measurements. Optical properties are discussed in the fourth chapter. Measurements on dopant- and light-induced changes in the optical spectra help to clarify many controversial aspects concerning the nature of the charge carriers and the question of electron–phonon and electron–electron interactions. It is important to note also that the nonlinear optical coefficients of these materials are high, so they could conceivably become useful in optical processing. The final chapter gives an account of the magnetic properties of these polymers. Nuclear magnetic resonance (NMR) and electron spin resonance (ESR) measurements allow direct probing of properties on a microscopic scale and can thus give detailed information which is otherwise not accessible, for example, we can establish whether the charge carriers induced by doping carry spin (i.e. are bipolarons, solitons or polarons). Data on spin dynamics also provide information on the mobility of the carriers, the spin distribution in defects and electron–electron interactions, which is otherwise difficult to obtain.

This book is dedicated to the late Prof. Günther Harbeke, who contributed to one of the chapters. His interest in the optical properties of condensed matter

stimulated much of the work which was followed up experimentally in the former Laboratories RCA Ltd., Zürich, and which finally helped to shape the chapter on optics. It is therefore with deep respect that the coauthors dedicate this book to his memory.

Zürich, February 1992 Helmut Kiess

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