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Advances in Polymer Science

Aims and Scope

The series Advances in Polymer Science presents critical reviews of the present and future trends in polymer and biopolymer science. It covers all areas of research in polymer and biopolymer science including chemistry, physical chemistry, physics, material science.

The thematic volumes are addressed to scientists, whether at universities or in industry, who wish to keep abreast of the important advances in the covered topics.

Advances in Polymer Science enjoys a longstanding tradition and good reputation in its community. Each volume is dedicated to a current topic, and each review critically surveys one aspect of that topic, to place it within the context of the volume. The volumes typically summarize the significant developments of the last 5 to 10 years and discuss them critically, presenting selected examples, explaining and illustrating the important principles, and bringing together many important references of primary literature. On that basis, future research directions in the area can be discussed. Advances in Polymer Science volumes thus are important references for every polymer scientist, as well as for other scientists interested in polymer science - as an introduction to a neighboring field, or as a compilation of detailed information for the specialist.

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Readership: Polymer scientists, or scientists in related fields interested in polymer and biopolymer science, at universities or in industry, graduate students.

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Elementary Processes in Organic Photovoltaics

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Preface

The transition to renewable energies is one of the most important and challenging tasks for humankind: On the one hand, the emission of carbon dioxide induces a climate change with negative consequences that are already visible today. On the other hand, the limited reserve of fossil fuels will not be able to provide sufficient supplies for the world's growing energy demand.

One of the most elegant principles of renewable energy generation is photovoltaics: They convert the most abundant energy source, light from the sun, directly into electrical energy. The last two decades have seen a rapid development in photovoltaics, leading to an already significant worldwide deployment of the technology. The current market leader is crystalline silicon technology, which has many advantages such as its high efficiency and stability. Nevertheless, there is a strong drive for novel technologies that could open up new application areas.

One technology with excellent potential is organic photovoltaics: This technology is based on carbon compounds; thus, the raw material is virtually inexhaustible. Furthermore, organic photovoltaics allow flexible modules on plastic foil substrates, which can be transparent and have adjustable color. The flexible substrates and the easy deposition of organic materials by methods such as printing offer the potential for low-cost roll-to-roll production. The main challenges for organic photovoltaics are their still comparably low conversion efficiencies and lack of stability.

This book presents a collection of chapters summarizing a large collaborative research effort of many groups: In the *Schwerpunktprogramm* (priority program) 1355 "Organic Photovoltaics" of the Deutsche Forschungsgemeinschaft (German Research Foundation), more than 150 researchers during the years 2008–2015 investigated the chemistry, physics, and engineering aspects of this technology. The collaborative effort within this research program led to substantial improvements and to a much better understanding of the working principles of the technology.

At the beginning of the program, the best efficiencies reported for organic solar cells were in the range of 6 %. During the course of the program, the efficiencies approximately doubled. The currently reported best value of 13.2 % is partially based on work performed in the framework of the program reported here.

One of the key aspects of research on organic photovoltaics is its interdisciplinarity: The work starts with the design of new molecules, which is a task for theoretical physics and chemistry, and continues with the synthesis of the materials by organic chemistry. Characterization and device principles are subjects of physics, while device design and module integration are engineering tasks. Accordingly, most of the individual projects reported in the chapters of this book are based on the close collaboration of researchers from different disciplines, and the new results reported address diverse subjects such as new molecules, novel characterization techniques, new device designs, and integration aspects such as novel electrodes.

I wish to thank the many persons who made the *Schwerpunktprogramm* and its publication in this book a pleasure: First, I am grateful to the many researchers who worked in a highly collaborative style on this challenging subject. I am glad that many of the younger researchers (and in particular the females among them) used this work as a stepping stone in their career to academic positions. I thank those colleagues who helped to successfully apply for the grant proposal. Finally, I thank Dr. Annette Polte for her competent coordination work, Dr. Michael Mößle and Dr. Stefan Krückeberg from the DFG, and Dr. Claus Ascheron from the publisher for the excellent collaboration.

Dresden, Germany Karl Leo

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