Preface

Dear Readers,

Since the ground-breaking, Nobel-prize crowned work of Heeger, MacDiarmid, and Shirakawa on molecularly doped polymers and polymers with an alternating bonding structure at the end of the 1970s, the academic and industrial research on hydrocarbon-based semiconducting materials and devices has made encouraging progress.

The strengths of semiconducting polymers are currently mainly unfolding in cheap and easily assembled thin film transistors, light emitting diodes, and organic solar cells. The use of so-called "plastic chips" ranges from lightweight, portable devices over large-area applications to gadgets demanding a degree of mechanical flexibility, which would overstress conventional devices based on inorganic, perfect crystals. The field of organic electronics has evolved quite dynamically during the last few years; thus consumer electronics based on molecular semiconductors has gained sufficient market attractiveness to be launched by the major manufacturers in the recent past.

Nonetheless, the numerous challenges related to organic device physics and the physics of ordered and disordered molecular solids are still the subjects of a continuing lively debate.

The future of organic microelectronics will unavoidably lead to new device-physical insights and hence to novel compounds and device architectures of enhanced complexity. Thus, the early evolution of predictive models and precise, computationally effective simulation tools for computer-aided analysis and design of promising device prototypes will be of crucial importance.

With regard to novel developments and challenges, the organizers of the SISPAD 2007 conference decided to organize an "Organic Electronics" Companion Workshop. World leading experts have been invited to Vienna to present their current work on this fascinating and important field of research. Subsequent to the workshop, all participants, together with those scientists who which were regrettably unable to join the conference, have been invited to contribute a chapter to the present volume of the book series "Advances in Polymer Science."

This foreword closes with a sketchy summary of each chapter. Here the chapter summaries have been arranged in the same order in which they appear in the book.

In the opening chapter, Evguenia Emelianova and Heinz Baessler analyze the dissociation of optically generated excitons into pairs of free carriers in the case of pure, blended and doped polymers. The effects of Gaussian disorder, temperature, and electric field on the photocarrier yield are investigated. As the presented analytical examination shows, energetic disorder enhances exciton dissociation. Moreover, the temperature dependence of the yield is weakened and loses the activated shape it exhibits in the case of moderate fields and zero disorder.

Priya Jadhav, Benjie Limketkai and Marc Baldo dedicated Chapter 2 to recapitulate experimental results, effective temperature models, and the percolation theory treatment with special emphasis on the compound AlQ_3. The authors discuss the applicability of percolation theory to the calculation of low-field carrier mobilities and debate the strengths and limitations of effective temperature models when being applied to a wider range of electric field strengths, lattice temperatures and carrier concentrations.

In Chap. 3, Sergei Baranovski presents various important theoretical concepts relevant to the transport theory of organic glasses, molecularly doped polymers and conjugated polymers.

Originally developed for amorphous inorganic semiconductors characterized by an exponential density of states, the author discusses the extension of these concepts to Gaussian densities of states under special consideration of state- and carrier-concentrations, electric fields, and temperatures.

In Chap. 4, Debarshi Basu and Ananth Dodabalapur drift velocity and drift mobility measurements in organic field effect transistors. A method is introduced which is based on the time-of-flight of an electron swarm injected into the channel by a voltage pulse. The method also grants an improved understanding of the injection process, the basic working mechanism of an organic transistor, and the nature of trap distributions.

In an organic thin film transistor, the relevant interfaces occur between the gate dielectric and the semiconductor and between the semiconductor and the source and drain contacts. In Chap. 5, Gilles Horowitz investigates the specific problems and sophisticated requirements arising in connection with these interfaces and describes how to characterize them and their effects on the device performance.

Low-cost polymer films are typically realized by solution-based technology. The resulting hole mobilities, however, lie below that of vapor deposited layers. Consequently, the performance of solution-based organic field effect transistors is limited. In Chap. 6, Susanne Scheinert and Gernot Paasch address the problems of low-cost sub-micrometer devices and present experimental results, contact problem simulations, and simulations of short-channel effects, which lead to short-channel design rules.

Birendra Singh and Serdar Sariciftci devoted Chap. 7 to the microelectronic applicability of the promising DNA-based bio-polymer DNA-CTMA. The authors present their work concerning the processing steps leading to feasible DNA-CTMA films and study the various characteristics of this compound. Properties like transparency, a large bandgap, or a tunable electrical resistance, to name just a few, make this polymer very interesting for the enhancement of numerous types of organic devices.

Christian Melzer and Heinz von Seggern discuss different ways to realize complementary organic CMOS inverters and present their basic design rules in Chap. 8. The authors illustrate several realizations of CMOS-like inverters and demonstrate an inverter based on two identical almost unipolar n- and p-type organic field effect transistors.

In Chap. 9 Alessandro Troisi blocks out disorder effects by focusing on the charge transport in crystalline organic media. In this way, the interplay between a compound's electrical characteristics and the chemical structure of the soft lattice "dressing" of the effective masses and energies by local distortions can be examined from a microscopic point of view by the means of computational chemistry.

In Chap. 10, Ling Li and Hans Kosina present compact models which they have recently derived. The addressed topics range from carrier-concentration dependent mobilities over analytical models describing the doping and trapping characteristics to a current injection model based on multiple trapping theory.

It was a great pleasure for us to cooperate with such outstanding scientists. We want to express our gratitude to all workshop-lecturers, book contributors, peer reviewers and last but not least to Dr. Hertel, Mrs. Samide and Mrs. Kreusel from Springer Verlag for facilitating and coaching the publication in the renowned book series "Advances in Polymer Science".

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