
Preface

One of the most exciting developments of the past two decades has been the emergence of organic electronics. This term refers to the use of organic materials as active layers in a variety of semiconductor devices. One example is organic light emitting diodes, devices which emit visible light upon the passage of current through an organic semiconductor film. These devices are now commercially available in small format flat panel displays and are being intensely developed for solid-state lighting. A second example is organic thin film transistors, which control the flow of electricity in circuits and are being developed for applications in smart tags and flat panel displays.

Concurrently, our need for sensors is ever increasing. Food safety, environmental monitoring, medical diagnostics, and homeland security are all areas that would benefit from the deployment of sensors and sensor networks. Improvements would be useful or even required on multiple fronts, including sensitivity and specificity, power consumption, portability, and cost. Organic semiconductors offer many advantages in comparison with their inorganic counterparts, which make them particularly attractive for sensor applications. First, they can be deposited at or near room temperature on large area surfaces and are compatible with mechanically flexible supports such as paper and plastic. This enables their use in roll-to-roll fabrication techniques, which can dramatically decrease manufacturing costs, an important attribute for disposable sensors. Second, their properties can be tailored by means of chemical synthesis. This includes electronic properties (such as energy gap and electron affinity) but also properties such as surface energy. Of particular interest for sensors is the ability to covalently attach biologically relevant moieties to organic semiconductor molecules. Such hybrid materials have the potential to lead to the fabrication of sensors with high sensitivity and specificity.

It is important to note that the main drawbacks of organic semiconductor devices are not detrimental to their application in sensors: Low-end performance, for example in terms of device speed, prohibits organics semiconductor devices from competing with silicon in high-end computing applications. This does not, however, constitute a limitation, as sensors can tolerate considerably

slower detection speeds. Moreover, long-term stability issues, which often plague organic semiconductor devices, are not relevant for disposable sensors. Therefore, sensors represent an application that can benefit from all the advantages of organic semiconductors and in principle suffers from none of the limitations. Quite naturally, the application of organic semiconductors and their devices in sensors has been attracting increased attention in the past few years.

This book covers central research directions in this rapidly emerging field. The first two chapters discuss fluorescence-based sensors and show how one can tailor organic semiconductors to yield large changes in their emission properties upon interaction with an analyte. The next two chapters deal with the application of organic light emitting diodes and photodetectors in sensors and their integration with lab-on-a-chip concepts. A variety of solid state devices are analyzed in the fifth chapter and the applications of lasing and photoconducting organic devices in sensors are proposed. The emphasis then shifts to electrical detection, first with field-effect transistors and then with electrochemical ones. In the remaining four chapters the mechanism of operation, the merits, and the potential applications of these devices in signal transduction are discussed.

We believe that the application of organic semiconductors and their devices in sensors will experience significant growth in the years to come. We hope that this book will serve as a useful text and reference for this emerging field.

Ithaca, New York, 2007

Dan Bernards
Róisín Owens
George Malliaras

Organic Semiconductors in Sensor Applications

Bernards, D.A.; Owens, R.M.; Malliaras, G.G. (Eds.)

2008, XVI, 290 p. 183 illus., Hardcover

ISBN: 978-3-540-76313-0