

Smart Sensors, Measurement and Instrumentation

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Series editor

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The Smart Sensors, Measurement and Instrumentation series (SSMI) publishes new developments and advancements in the fields of Sensors, Instrumentation and Measurement technologies. The series focuses on all aspects of design, development, implementation, operation and applications of intelligent and smart sensors, sensor network, instrumentation and measurement methodologies. The intent is to cover all the technical contents, applications, and multidisciplinary aspects of the field, embedded in the areas of Electrical and Electronic Engineering, Robotics, Control, Mechatronics, Mechanical Engineering, Computer Science, and Life Sciences, as well as the methodologies behind them. Within the scope of the series are monographs, lecture notes, selected contributions from specialized conferences and workshops, special contribution from international experts, as well as selected PhD theses.

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Anindya Nag · Subhas Chandra Mukhopadhyay ·
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Printed Flexible Sensors

Fabrication, Characterization
and Implementation

 Springer

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Preface

Flexible sensors have exhibited immense potential to be utilized for healthcare, environment and industrial applications. The full-blown exploitation of these types of sensors is yet to be carried out to cause an impact on the quality of life of people. The work shown here showcases a great dynamicity in the employment of some of the sensors in the application world. Among a range of techniques that can be used to fabricate the flexible sensing prototypes that differ with respect to size, cost and resolution, the use of printing technology had been considered to a large extent. The research done on printed flexible sensors has been constantly increased due to certain advantages like low cost, enhanced electrical and mechanical attributes. The work shown in this book explains the fabrication of novel flexible printed sensors using laser cutting and 3D printing techniques. Four types of printed flexible sensing prototypes were designed, fabricated and implemented for some of the healthcare, environmental and industrial applications.

The main motive behind the development of each of the developed sensors can be ascribed to their low cost of fabrication, simple operating principle and multi-functional characteristics. The electrical nature of the sensor was based on the capacitive principle due to the interdigital design of their electrodes. Electrochemical impedance spectroscopy was used along with the sensor prototypes to analyse the change in their outputs with respect to different inputs. The differences among these prototypes were based on their characteristics as a result of the difference in raw materials used to fabricate them. Multi-walled carbon nanotubes, graphene, aluminium and graphite are some of the conductive materials that were considered to form the electrodes of the sensor prototypes for their lightweight, high electrical conductivity, robustness and high aspect ratio. Polydimethylsiloxane, polyethylene terephthalate and polyimide are some of the polymers that were considered to form the substrates for their low cost, biocompatibility, low Young's modulus and capability to form flexible multi-layered structured devices. The sensor prototypes were considered for different fields like monitoring of physiological movements, respiration and taste sensing for healthcare, monitoring of salinity and nitrate concentrations in water bodies for environment, and tactile and low-force sensing for industrial applications. The futuristic

uses of the fabricated sensors could include their real-time applications for chemical and biological sensing of proteins and similar enzymes, different gases, temperature and humidity. Considering their small size and biocompatible nature, they can also be utilized as implantable sensors to analyse the anatomical changes taking place inside the body of a human being. They can also be employed for applications of national importance like military and defences, where they can be attached along with adaptive feedback systems on the wings of a plane to calculate their active flutter suppressions.

The work elucidated in this book is obtained from a doctoral research done at Macquarie University, NSW, Australia.

The objective of this work was to develop different flexible printed sensors to highlight and enhance the field of printing technology. The developed sensors were reliable with high durability, low response time and higher repeatability in their responses.

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