Smart Sensors, Measurement and Instrumentation

Volume 33

Series editor

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Printed Flexible Sensors

Fabrication, Characterization and Implementation

Springer

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ISSN 2194-8402 ISSN 2194-8410 (electronic)
Smart Sensors, Measurement and Instrumentation
ISBN 978-3-030-13764-9 ISBN 978-3-030-13765-6 (eBook)
https://doi.org/10.1007/978-3-030-13765-6

Library of Congress Control Number: 2019931841

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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 fabricated 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.

The authors are highly obliged to their colleagues who had a significant contribution to this work: Nasrin Afsarimanesh, Md Eshrat E. Alahi, Van Nguyen Thi Phuoc, Ulrich Buttner, Dr. Ahmed Alfadhel, Niki Murray, Mario Codeniera, Walter Adendorff and Dr. Keith Imrie. A special thanks to Macquarie University, Australia, and Massey University, New Zealand, for providing research facilities to fabricate the sensors and utilize them for specific applications. We would also like to extend our gratitude to our families for their immense support, motivation and encouragement throughout the work.

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