Additive Manufacturing of Flexible Sensors

Introduction

Fabrication and assembly of flexible sensors play important roles in improving the performance of wearable electronics. Traditional manufacturing techniques have limitations in controlling the geometry and architecture of the sensing systems, which compromise their performance as well as applications. Additive manufacturing (also known as 3D printing) techniques such as stereolithography and direct ink writing (DIW) are gaining popularity in the fabrication of flexible sensors because of its following advantages:

- No injection molding
- Fast preparation and high accuracy
- Flexibility in structure design
- Batch production

[1] Lattice-Structure Pressure Sensor (LPS)

- The LPS is prepared by using stereolithography 3D printing technique
- Fast and volume preparation (55 green models produced in 30 minutes)

Sensor Structure Optimization

- We compare the influence of lattice types on the compressive behavior and electrical response of LPS

Healthcare Monitoring Applications

- The LPS is used for real-time pulse monitoring
- A flexible 4×4 sensing array is designed to detect spatial pressure distribution
- A foot pressure measuring system is built to monitor dynamic pressure evolution at walking state

[2] Pressure-Temperature Sensor (PTS)

- The dual parameter PTS is prepared by using DIW 3D printing technique
- The PTS has hierarchical porous microstructures and is ultralight (0.2 g)

Decoupled Pressure and Temperature Sensing

- The pressure and temperature sensing are based on piezoresistive effect and thermoelectric effect, respectively
- Based on the separated signal responses, the PTS can discriminate between "artificial finger touch", "human finger touch" and "human finger approach"

Intelligent Human-Machine Interaction (HMI)

- An intelligent HMI system is developed for high temperature alarm and intelligent action feedback

Conclusions

- We demonstrate [1] a programmable lattice-structure flexible pressure sensor and [2] a flexible pressure-temperature dual parameter sensor using additive manufacturing techniques
- Additive manufacturing shows advantages in producing high performance flexible sensors with high convenience of structural design, which enables its promising applications in healthcare monitoring and human-machine interactions

Acknowledgements

Ningbo 3315 Talent Scheme and Ningbo Scientific and Technological Innovation 2025 Major Project (Grant No. 2018B10057) by Ningbo Science and Technology Bureau.

[1] Published on ACS Appl Mater Interfaces 2021 13, 10388-10396.
DOI: 10.1021/acsami.0c021407
[2] Unpublished work