ECO-CONSCIOUS APPROACH TO WIRELESS GAS MONITORING: DEVELOPMENT OF A HYBRID NFC SENSOR TAG

Authors

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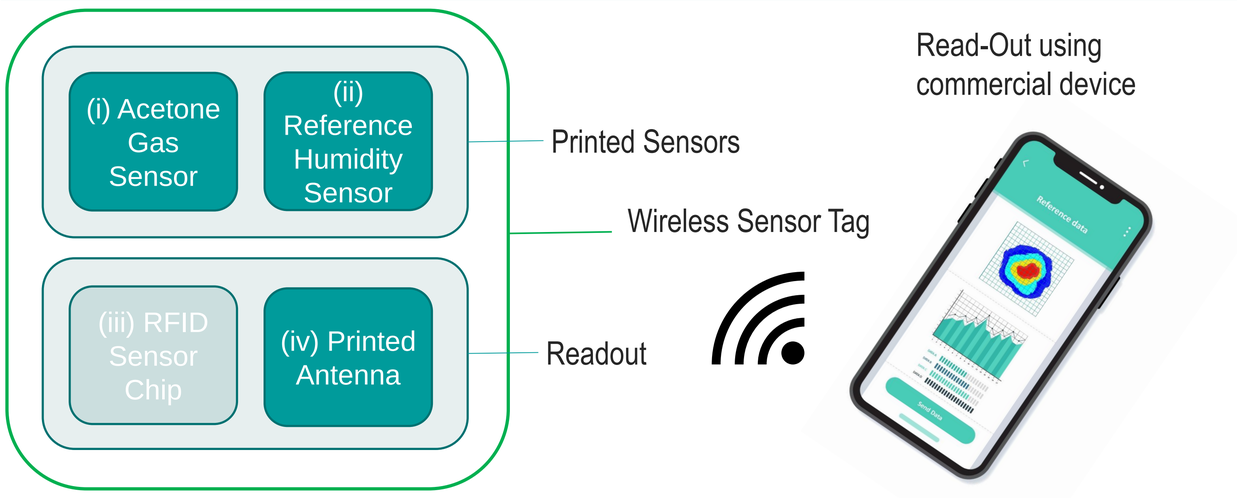
Abstract

Employing advanced functional printing methodologies, an innovative and sustainable sensor solution for wireless gas monitoring is presented. One of its distinguishing features lies in the utilization of a passive near field communication (NFC) chip, negating battery dependency by drawing power from the ambient electric field while transmitting data wirelessly to a read-out device (e.g. smartphone). The sensor tag is mostly fashioned from renewable, biodegradable materials. Moreover, digital additive manufacturing and low temperature processing mark a stride toward eco-friendliness in gas sensing technology.

Introduction and Concept



Motivation:

–Realization of a disposable gas sensor patch which can be attached to a smart phone for e.g. breath monitoring or environmental monitoring

Characteristics:

–Additively manufactured
–Passive: no battery
–Integration of commercial sensor chip
–Employ bio-based substrate and sensing materials
–Room-temperature processing

Materials and Methods

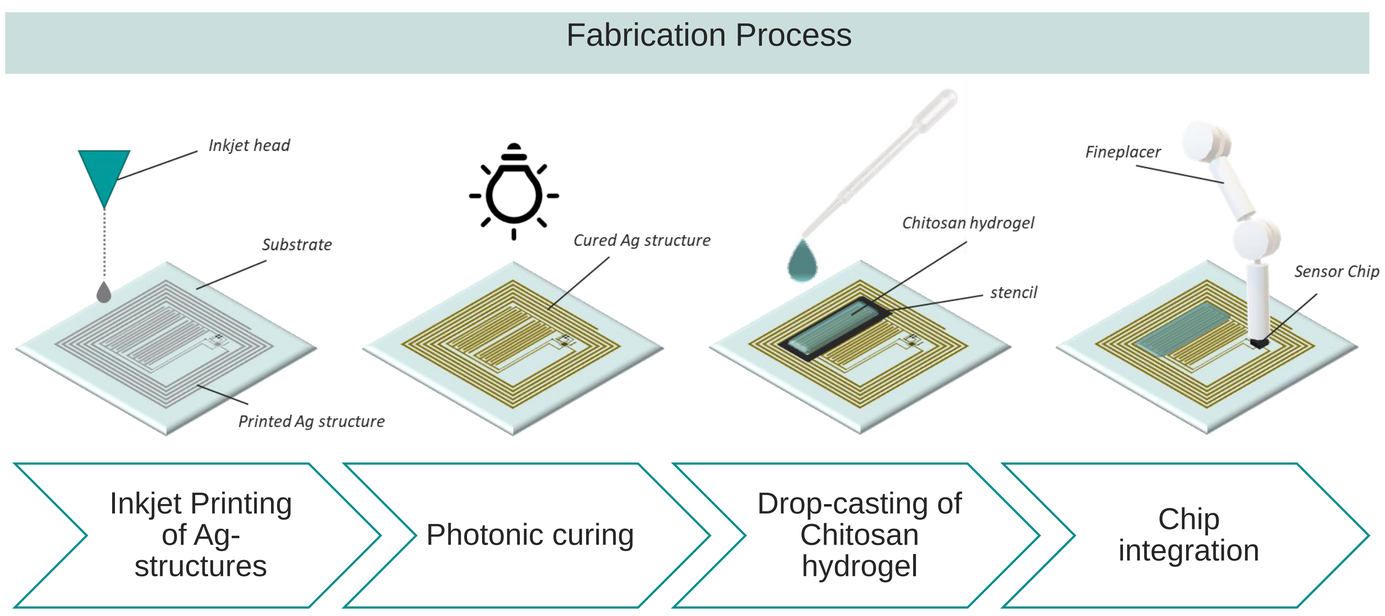
NFC Sensor Chip:

–SIC4340, Silicon Craft, Thailand
–Parallel readout of 3 different capacitive/resistive sensors
–Read-out via near field communication (NFC, 13.56 MHz) using a smartphone (Samsung, Korea)
–Flip-chip bonding with Fineplacer (Finetech, Germany) using pressure-sensitive anisotropic conductive adhesive tape (3M, USA)

Sensors:

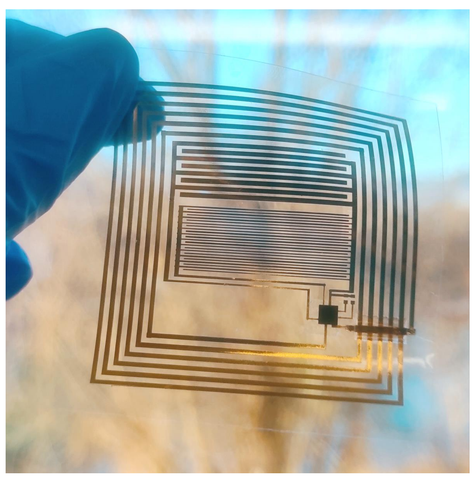
–Printed, bio-based Chitosan sensor for Acetone detection (linear range between 0 -73 ppm) [1]
–Integration of printed capacitive reference humidity sensor [2] to compensate for Chitosan's cross-sensitivity to humidity [3]

Fabrication Process

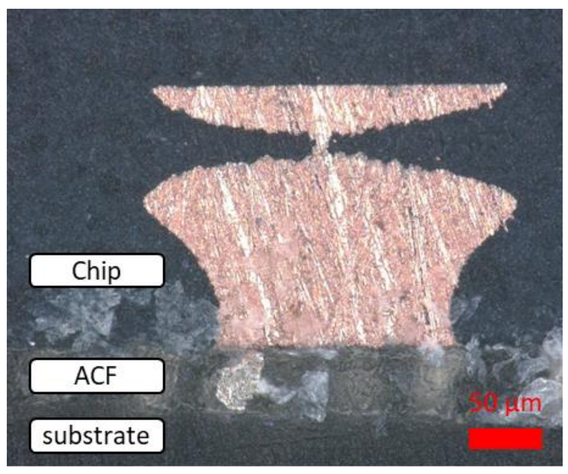


Results and Conclusion

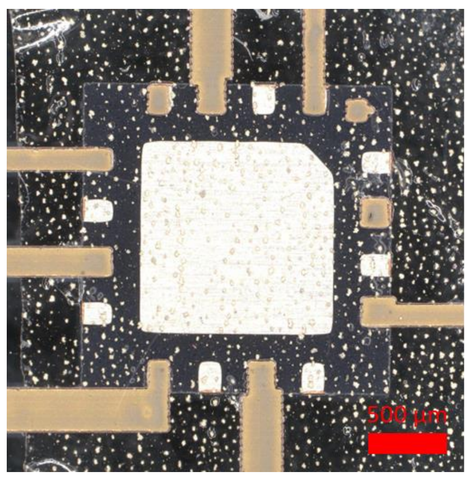
Prototype



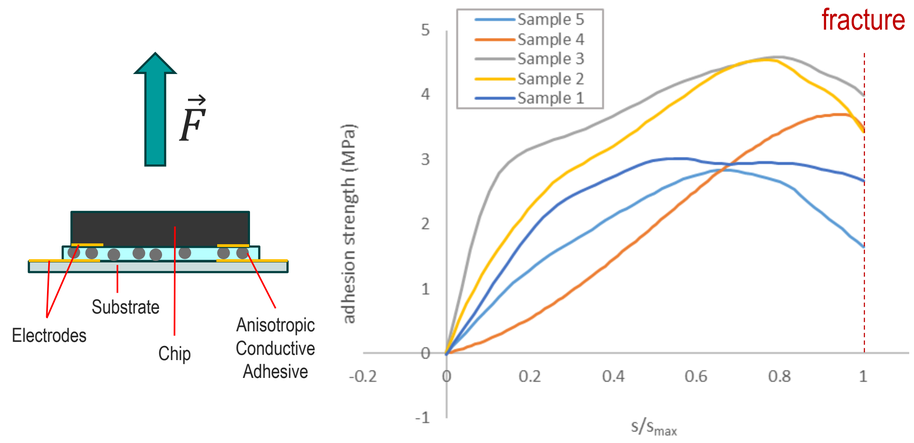
Bonding: Cross-Section



Integrated Chip (bottom-view)



Chip Pull-Off Test



Chip Integration:

– Room-temperature processing
– 6 Nmm^{-2} applied for 45 s
– Average adhesion strength of 3.74 MPa

Conclusion:

- Stable NFC communication with smartphone can be established
- Room-temperature chip bonding
- Demonstration of a more sustainable approach to wireless gas sensing compared to conventional state-of-the-art sensors, which rely on non-renewable materials.

References

[1] Zikulnig, J., Lengger, S., Rauter, L., Carrara, S., & Kosel, J. (2023, June). A Sustainable Printed Chitosan-Based Sensor for Acetone Detection. In *2023 18th Conference on Ph. D Research in Microelectronics and Electronics (PRIME)* (pp. 121-124). IEEE.

[2] Rauter, L., Zikulnig, J., Moldaschl, T., Lenzhofer, M., Khan, S., Neumaier, L., ... & Kosel, J. (2023). Sustainable Multifunctional Biface Sensor Tag. *Advanced Sensor Research*, *2*(3), 2200027.

[3] Zikulnig, J., Lengger, S., Rauter, L., Neumaier, L., Carrara, S., & Kosel, J. (2022). Sustainable Printed Chitosan-Based Humidity Sensor on Flexible Biocompatible Polymer Substrate. *IEEE Sensors Letters*, *6*(12), 1-4.

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