Chipless Sensing Antenna and an NFC Smart-Tag for Measuring Temperature

Mitradip Bhattacharjee(1,2), Fatemeh Nikbakhtnasrabadi(2), and Ravinder Dahiya*(2)
(1) EECS, Indian Institute of Science Education and Research (IISER) Bhopal, India - 462066
(2) Bendable Electronics and Sensing Technologies (BEST), University of Glasgow, UK, G12 8QQ;
Correspondance to: Ravinder.Dahiya@glasgow.ac.uk

Sensor integration is gaining attention as we are moving towards a smart society day by day. In this direction, wireless connectivity plays an important role and it enables the internet of things (IoT) more accessible for the users. Hence, the concept of sensing antenna has gained significant attention. In this view, two different approaches of using an antenna have been discussed here,[1, 2] (i) a sensing antenna capable of measuring temperature and (ii) a smart tag having temperature sensors. The sensing antenna is designed for 1-2 GHz and 5.5-5.8 GHz range whereas the smart tag uses an NFC i.e. 13.56 MHz antenna. A temperature sensor with similar characteristics has been used in both cases.

The resistive printed temperature sensor was fabricated with silver electrodes and PEDOT:PSS on a flexible PVC substrate as shown in Fig. 1 (a-c). This sensor shows a 70% change in resistance for a tested temperature range from 25ºC to 90ºC (Fig.1 (d)). The fluctuations in the linear fit (Fig. 1(e)) indicate ~2.7% noise for the sensor and the temperature resolution is calculated to be ~2 °C.

A printed temperature sensing loop antenna (Fig. 1(f)) has been fabricated on a flexible PVC substrate at 5.5-5.8 GHz frequency range. The antenna also has another resonating band in 1-2 GHz. A comparative study was performed with a glass-based rigid antenna. The flexible antenna was found to be more efficient in terms of applicability and performance. Similarly, the NFC antenna for the smart tag (Fig. 1(g)) has been fabricated on a flexible printed circuit board (PCB). The NFC tag consists of an RFID chip (RF430FRL154H) which is a 13.56-MHz transponder with a programmable 16-bit MSP430 low-power microcontroller.

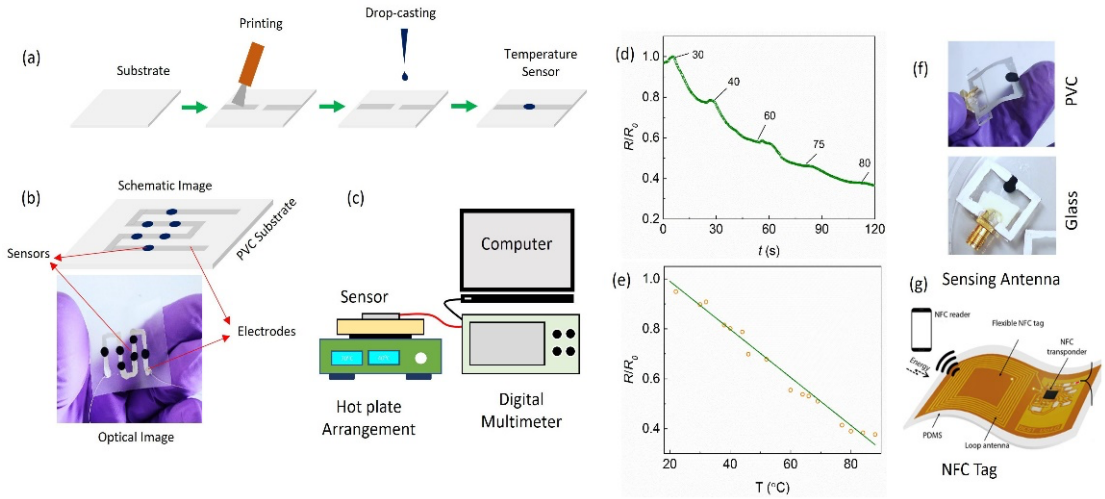

Figure 1. (a) Fabrication of temperature sensor, (b) schematic and the optical image of the fabrication sensor, (c) temperature sensor experimental set-up, (d) temporal response of the sensor, (e) the response of the sensor for different temperature, (f) the sensing antenna, (g) the smart tag.

A sensitivity of ~1.2%/ºC has been observed for the sensing antenna in the GSM frequency range. The sensing antenna is found to be suitable for bending applications as well. Similarly, a custom-developed passive NFC tag with an LED connected in series to the temperature sensor is powered from an NFC reader to detect the temperature in a semi-quantitative way. The chipless sensing antenna provides better portability whereas on-system RF energy harvesting can be provided using the discussed smart-tag.

References

[1] M. Bhattacharjee, F. Nikbakhtnasrabadi, and R. Dahiya, "Printed Chipless Antenna as Flexible Temperature Sensor," *IEEE Internet of Things Journal,* pp. 1-1, 2021.doi: 10.1109/jiot.2021.3051467.

[2] P. Escobedo, M. Bhattacharjee, F. Nikbakhtnasrabadi, and R. Dahiya, "Smart Bandage with Wireless Strain and Temperature Sensors and Battery-less NFC Tag," *IEEE Internet of Things Journal,* pp. 1-1, 2020.doi: 10.1109/jiot.2020.3048282.