School of Electronics and Computer Science

DESIGN OF TEXTILE ANTENNA FOR MOISTURE SENSING

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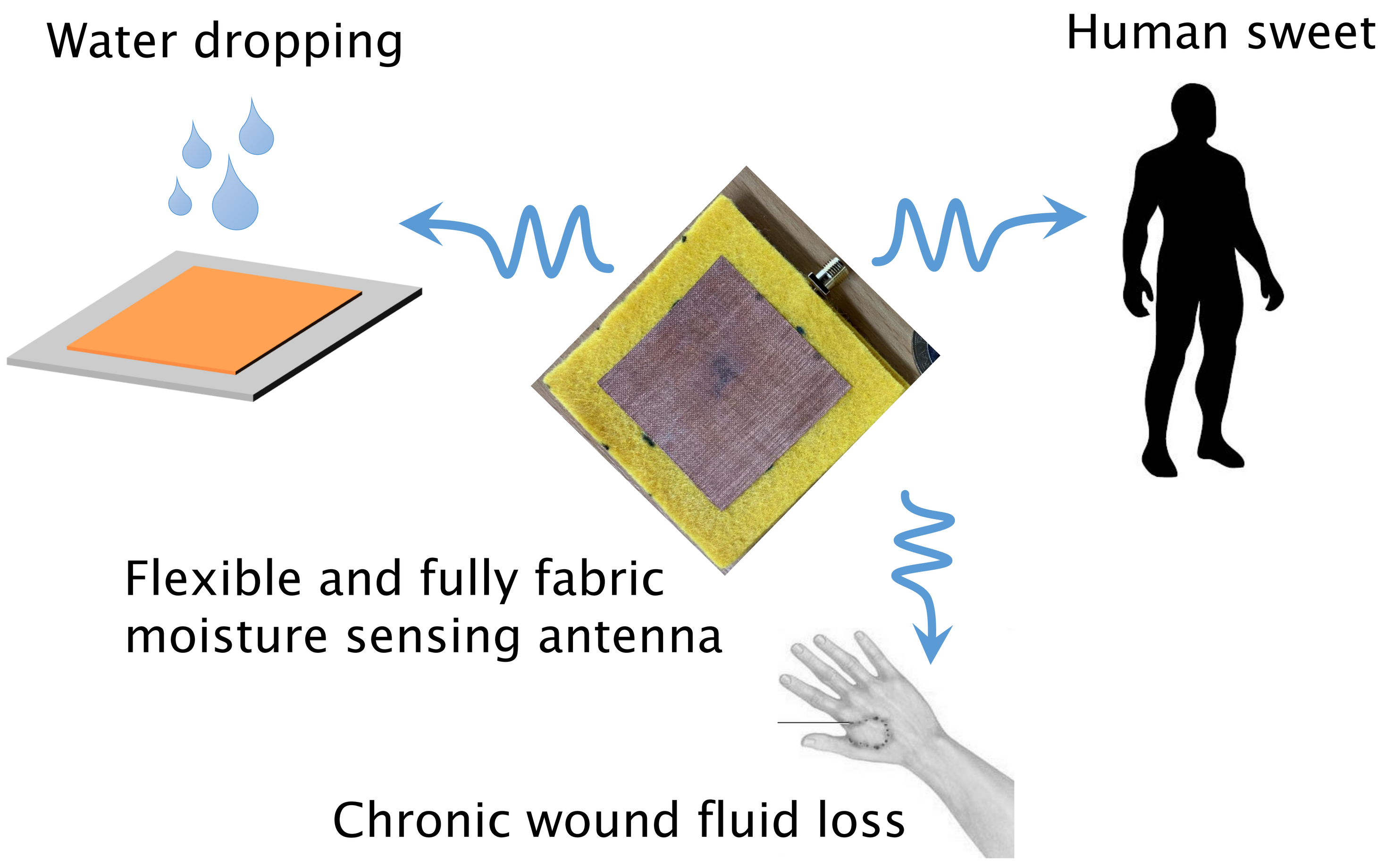
Introduction

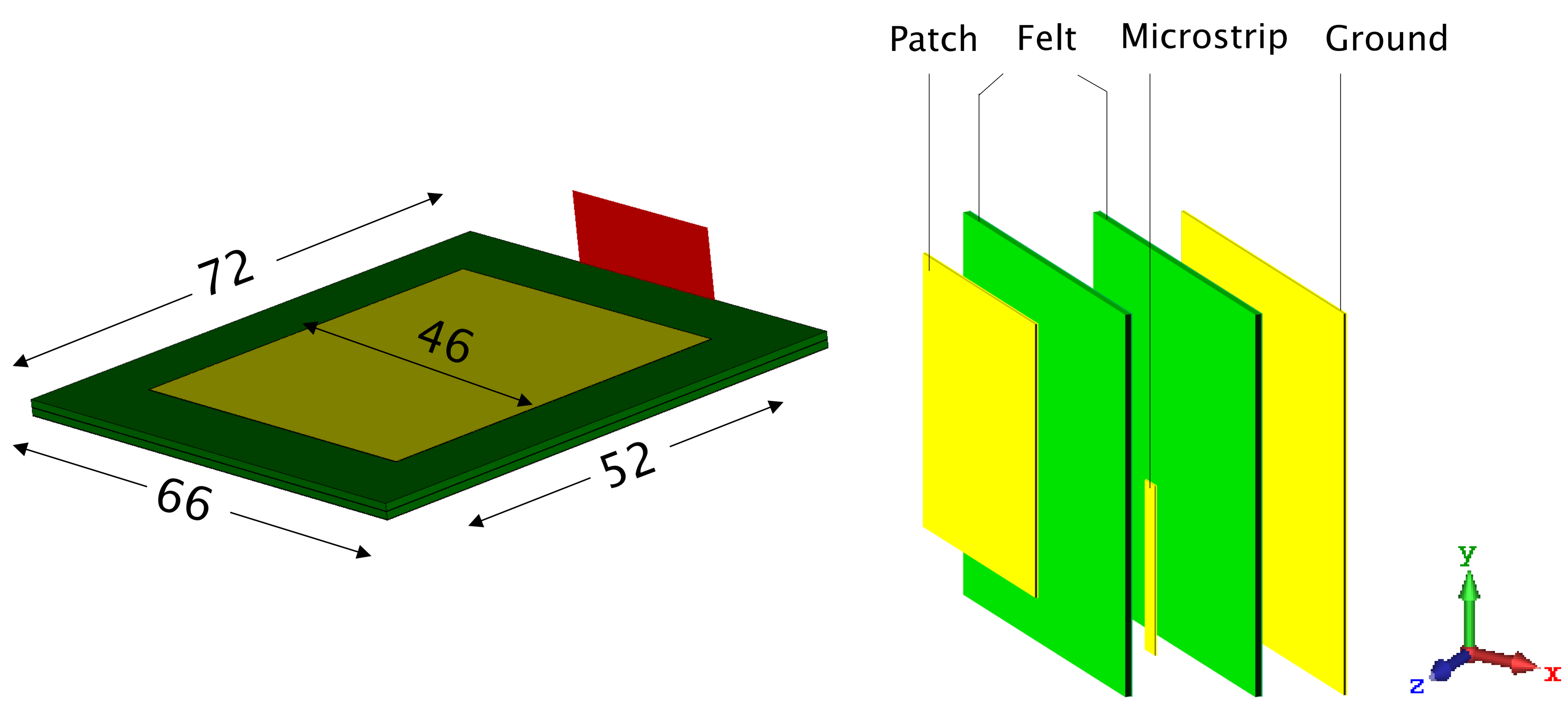
There has been an increased interest in designing antenna sensors due to their sample structure, low-cost, battery-free and wire-free operation. Most of the antenna sensors have been designed on rigid substrate for various applications, such as temperature sensing, crack sensing, strain sensing, dielectric sensing and so on. In this study, a design of an e-textile microstrip patch antenna for wireless sensing of the moisture content of a fabric substrate is presented which is suitable for a variety of applications such as sweat and wound monitoring.



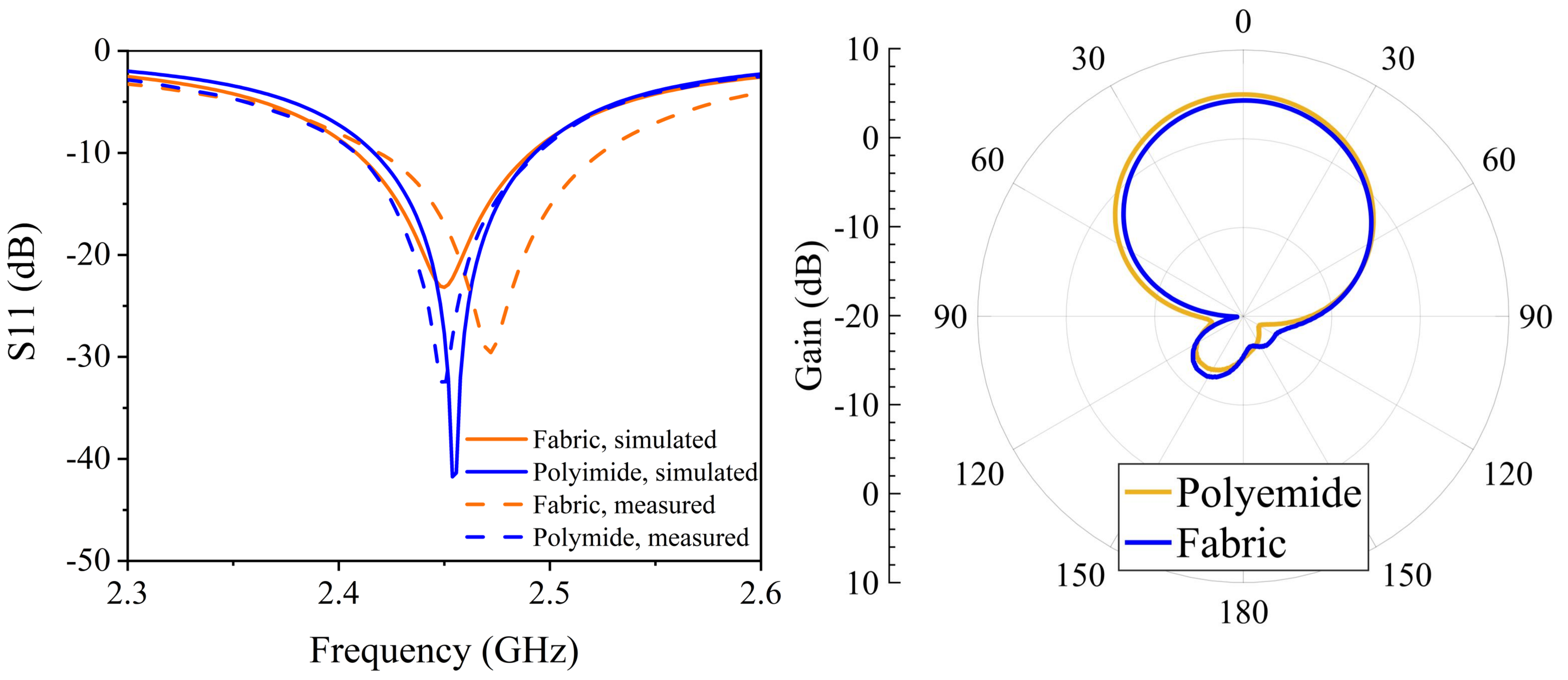
The applications of an antenna as a moisture sensor

Sensor Antenna Design

- 2.4 GHz microstrip patch antenna
- Felt-based Two prototypes: All-fabric and flexible copper construction
- Multi-layered substrate with contact-free proximity feed



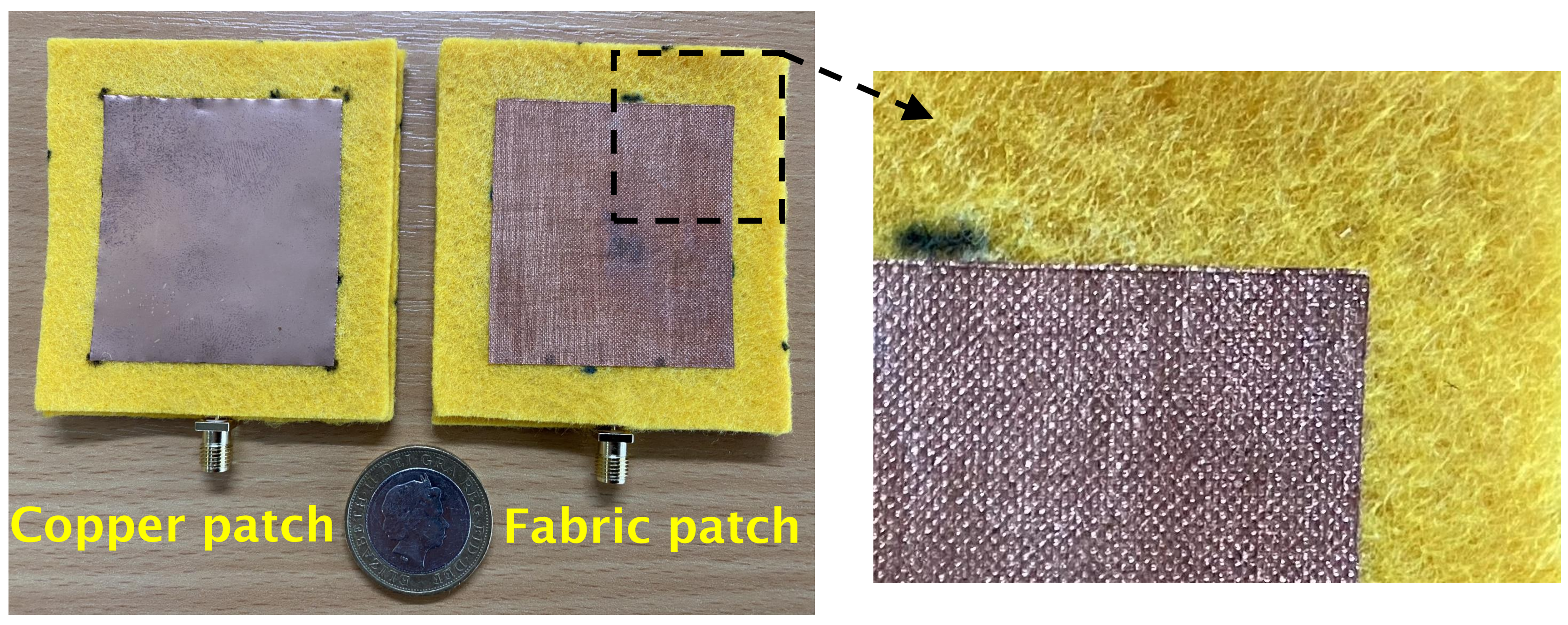
Proposed proximity coupled microstrip patch antenna for moisture sensing. (All dimensions in mm)



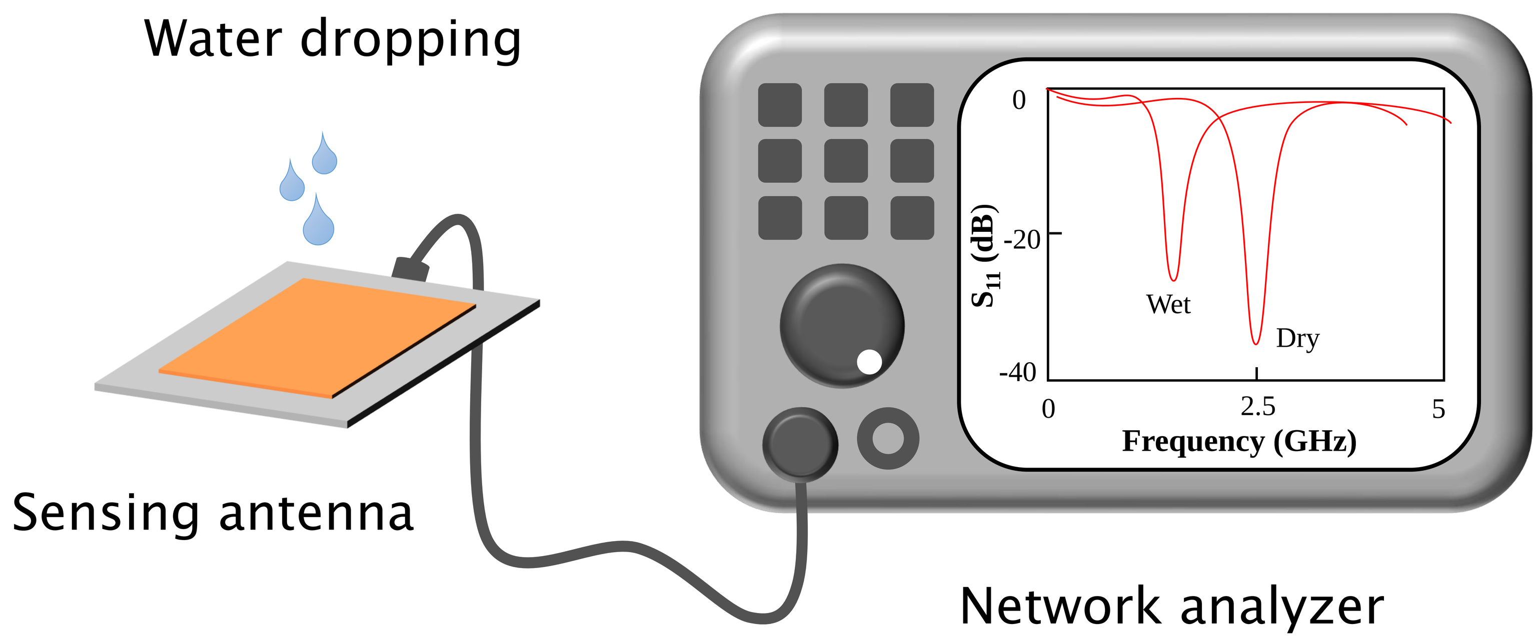
Simulated and measured S_{11} and radiation pattern (yz-plane) of the patch antenna, showing the S_{11} > -10 dB, Gain = 4.98 dB, and radiation efficiency is 49.5% at 2.45 GHz

Results

- Each antenna was exposed to moisture contents (20—100%)
- And calibrated network analyzer was used to measure the S_{11} of the antenna
- Measured S_{11} shows that the antennas are well matched (S_{11} > -10 dB**)** at 2.45 GHz

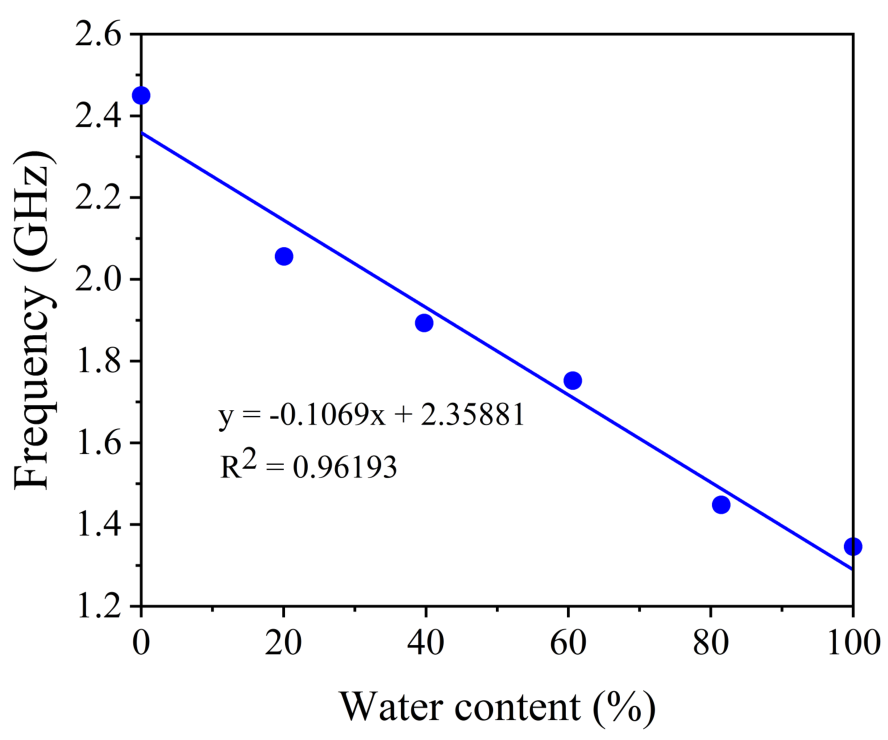


Manufactured patch antennas design

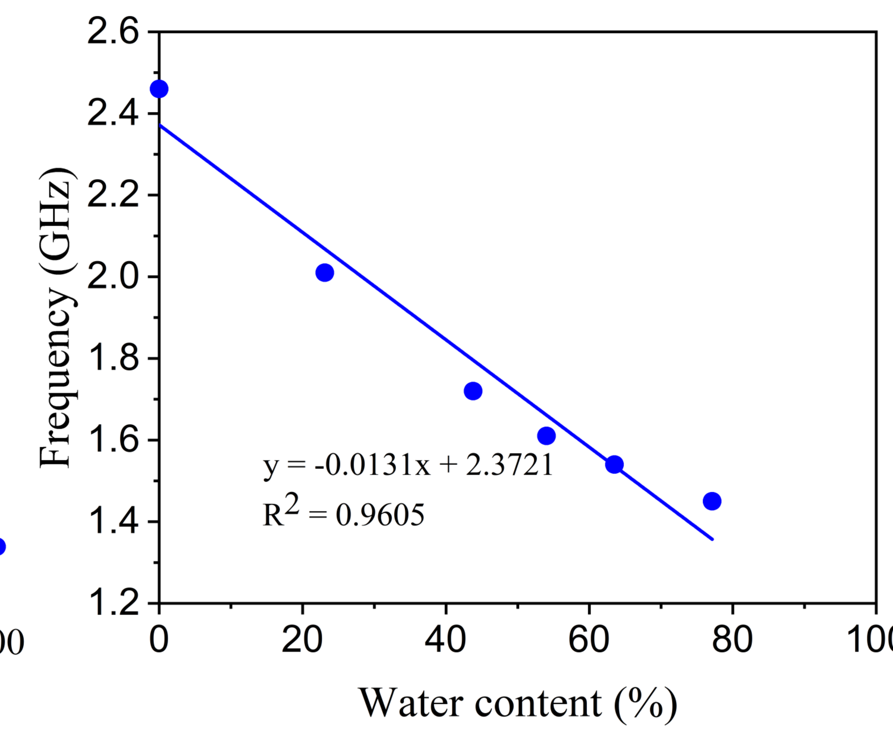


Measurement setup

- As the substrate gradually absorbs more water, the antenna resonance frequency shifts to lower band where 0% refers to the dry antenna
- At the dry state, both antennas resonate in the 2.4 GH ISM band
- When the antenna is fully wet, the polyimide antenna resonates at 1.34 GHz while the fabric antenna resonates at 1.45 GHz
- The shifting in the antenna resonance frequency determines the moisture absorbed by the fabric, and hence the sensor response



Effect of the water content on the resonant frequency of the polyimide antenna



Effect of the water content on the resonant frequency of the fabric antenna

Conclusions

A moisture sensing patch antenna has been demonstrated which enables low-cost moisture sensing. The antenna is flexible, low-cost, easy to fabricate and can be seamlessly integrated with clothing for on-body applications. The resonance frequency of the antenna shifts to a lower frequency band as antenna absorbs more moisture. This shift in the resonance frequency of the antenna indicates the amount of moisture absorbed by the fabric.
The object of the future work is to investigate different types of fabrics which are more absorbent, such as escalade, cotton and linen.