Proceedings of the Canadian Society for Mechanical Engineering International Congress 2021
CSME Congress 2021
June 27-30, 2021, Charlottetown, PE, Canada

METAMATERIAL-INSPIRED RF CHIPLESS TAG FOR REAL-TIME NON-INVASIVE MONITORING IN MICROFLUIDIC DEVICE

Zahra Abbasi, Weijia Cui, Carolyn L.Ren
Department of Mechanical and Mechatronics Engineering, University of Waterloo, Canada
{z8abbasi, w27cui, c3ren}@uwaterloo.ca

ABSTRACT

This abstract presents a microwave-microfluidic sensing platform for monitoring the complex permittivity of an individual droplet. Microfluidics has recently been developed as a powerful platform for biochemical reactions due to several advantages such as low reagent usage, precise control of reaction variables, and fast reaction rate. However, sensing and verification in microfluidic devices mostly rely on expensive and bulky optical equipment and high-speed cameras. Microwave resonator-based structures have been used for sensing applications. Among all the structures, planar microwave sensors are preferred candidates compared to the other complicated and bulky microwave structures because of their inexpensive and easy fabrication process, lab-on-a-chip compatibility, and label-free detection. The principle of operation in microwave sensors is based on the interaction between the fringing electromagnetic (EM) field distribution created by the structure and the sample under the test. This empowers microwave sensing to perform real-time measurement without having physical contact with the sample under the test. However, the lower fringing field in the planar microwave resonator-based sensors is a limitation for the structure to be applied for highly sensitive applications such as droplet sensing. To enhance sensitivity, a coupled microwave reader-tag design is proposed as the sensor where metamaterial-inspired chipless RF tag is the main sensing element integrated with the microfluidic device. Using the chipless tag as the sensing element not only enhances the electric fringing fields and the sensitivity of the structure but combining it with a microfluidic device creates a user-friendly, low-cost, contamination-free microfluidic sensory device. Integration of the tag with a microfluidic device enables robust wireless sensing performance, making them a strong candidate for non-invasive biomedical sensing applications. The performance of the microwave microfluidic sensor has been validated in monitoring conductivity and permittivity of the sample using mixtures of DI water, Isopropyl alcohol (IPA), and NaCl. The sensor offers selectivity for measuring the concentration of IPA in DI Water in the sample and the salinity level of the sample.