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Abstract

Sensitivity Analysis of a Portable Wireless PCB-MEMS Permittivity Sensor Node for Non-Invasive Liquid Recognition †

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Abstract: Dielectric characteristics are useful to determine crucial properties of liquids and to differentiate between liquid samples with similar physical characteristics. Liquid recognition has found applications in a broad variety of fields, including healthcare, food science, and quality inspection, among others. This work demonstrates the fabrication, instrumentation, and functionality of a portable wireless sensor node for permittivity measurement of liquids that require characterization and differentiation. The node incorporates an interdigitated microelectrode array as transducer, and a microcontroller unit with radio communication electronics for data processing and transmission, which enables a wide variety of stand-alone applications. A laser-ablation-based microfabrication technique is applied to fabricate the microelectromechanical systems (MEMS) transducer on a printed circuit board (PCB) substrate. The surface of the transducer is covered with a thin layer of SU-8 polymer by spin coating, which prevents direct contact between the Cu electrodes and the liquid sample. This helps to enhance durability, avoid electrode corrosion and contamination of the liquid sample, and to prevent undesirable electrochemical reactions from arising. The transducer's impedance was modelled as a Randles cell, having resistive and reactive components determined analytically, using a square wave as stimuli and a resistor as a current-to-voltage converter. To characterize the node sensitivity under different conditions, three different transducer designs were fabricated and tested for four different fluids—i.e., air, isopropanol, glycerin, and distilled water—achieving a sensitivity of 1.6965 +/− 0.2028 ε_r/pF. The use of laser ablation allowed the reduction of the transducer footprint while maintaining its sensitivity within an adequate value for the targeted applications.

Keywords: PCB-MEMS; permittivity sensor; liquid recognition

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