IEEE Sensors Journal, vol.21, no.18, pp.20156-20164, September, 2021.

A novel dielectric resonator-based passive sensor for drop-volume binary mixtures classification

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Abstract-

In this study, the authors present a dielectric-resonator based sensor to characterize liquids. The sensor is based on a dielectric resonator (DR) fed by a slot-coupling mechanism in the ground plane of a microstrip transmission line (TL). The obtained device is a fully passive sensor that a radiofrequency (RF) signal can interrogate. A small hole was drilled on the DR surface to allocate a drop of the liquid under test (LUT); as a consequence, the resonant frequency of the sensor will depend on the electromagnetic characteristics of the LUT. The device is modeled both with an equivalent circuit model and through an electromagnetic modal analysis. The cavity perturbation technique is used to study the impact of the LUT on the resonant frequency and modal distribution; full-wave simulations corroborate the theoretical results. Finally, a prototype of the proposed sensor tuned to work in the 2.45 GHz band has been designed, manufactured, and measured. The device is cost-effective given the small size and practical to use, thanks to the minimal volume of the pool, which calls for quantities of LUT in the order of 0.13. The prototype has been tested with an ethanol-water solution set. The experimental results match well with simulations and show good repeatability. The sensitivity of the prototype resulted in being 718 kHz per percentage of ethanol in water.

Index Terms- Dielectric Resonator (DR), Electromagnetic sensor, ISM band, Liquid sensor.

Citation:
Gholami Mayani, M.; Herraiz-Martínez, F.J.; Matanza, J.; Giannetti, R.; Rodríguez-Morcillo, C. "A novel dielectric resonator-based passive sensor for drop-volume binary mixtures classification", IEEE Sensors Journal, vol.21, no.18,

pp.20156-20164, September, 2021.