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Industrial Liquid Characterization Enhancement using Microwave Sensor equipped with Electronic Band Gap Structure

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Abstract **—In this paper, we present a novel sensor for permittivity measurement of the industrial liquids to achieve more sensitivity. An electronic band gap (EBG) structure is used. The simulation results show that applying EBG scheme enhances the electric field strength at the measuring part. This issue causes a significant shift in resonant frequency and therefore an increased sensitivity of the designed sensor. The proposed sensor is tested for characterization of liquids with various permittivity and loss tangent values, and the results show the proposed sensor can precisely classify a wide range of liquids in terms of electromagnetic properties. Measurement results indicate that the presented sensor is well suited for transformer oil aging applications.**

Index Terms - Electronic band gap, **material characterization, metamaterial,** ***Permittivity sensor***

I. Introduction

Determination of the material characteristics such as permittivity and permeability is very important in various applications such as medical and industrial processes for solid and liquid materials [1-3]. For this aim, microwave sensors are being interested because of high accuracy and compact size [4]. Different techniques have been developed for material detection such as hybrid resonant/transmission-reflection method [5] and cavity resonance method [6] and based on these schemes various sensor models have been designed [1-7]. Metamaterials are artificial structures with unique attributes and recently have been implemented in antenna and microwave system for improving the radiation and energy based on its left hand characteristic [8-9].