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Metamaterial Split Ring Resonators made of Polyaniline - polytetrafluoroethylene at Microwave Frequencies

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Abstract – **We present the observance of magnetic resonance for the first time in Split Ring Resonators (SRRs) made of polyaniline - based conducting polymer and verify our experimental result through simulation. The magnetic resonance behavior of Closed Ring Resonator (CRR) and SRR of polyaniline - polytetrafluoroethylene (Pani - PTFE) are presented. The humidity sensitive conducting Pani - PTFE ring behaves like low loss conducting ring with wide-band magnetic resonance whereas the CRR does not show any resonant response as is expected. The results are analyzed using simulation studies for copper rings of similar dimensions. Magnetic resonance observed in Broad-side Coupled Split Ring Resonator (BCSRR) made of Pani - PTFE is also presented, highlighting its role in metamaterial based applications. Realization of metamaterial resonating structures using conducting polymers opens a new realm with immense possibilities in microwave and terahertz technologies.**

I. Introduction

Conducting polymers has emerged as one of the key areas of research during the last decade in the field of electromagnetic sensors and absorbers. Apart from using conducting polymers for slightly modifying the environmental conditions of the Split Ring Resonator (SRR), no other works are seen reported in the literature[1]. In this work, for the first time, we have fabricated the metamaterial based Broad-side Coupled Split Ring Resonator (BCSRR) structure using polyaniline - polytetrafluoroethylene (Pani - PTFE) conducting polymer and have analyzed its magnetic resonance behavior. This paper also addresses the observance of the widening of resonance curve in relation to the comparatively less conductivity of the proposed polymer with respect to the conventional metallic resonators. During the course of development of BCSRR, we have also analyzed the magnetic resonant behavior of Closed Ring Resonator (CRR) and SRR fabricated using conducting polymer. Experimental results are verified using high frequency simulation software and excellent agreement are observed.

II. Materials and methods

For metallic resonators, the inductive contribution of the resonant frequency exclusively depends on the conduction current flowing through the ring. But since Pani - PTFE is a material having lower conductivity, the displacement current term which is a property of dielectric counterpart of the resonator should also be included in the calculation of the resonant frequency. The effective length of the resonating ring l_1 along with the resonant frequency Ω are given[2] by

$$l_1 = \ln[8R/r] - 7/4 \tag{1}$$

$$\Omega = \omega_o\sqrt{1 + 2\varepsilon k} \tag{2}$$

where ω_o is given by

$$\omega_0^2 = 2c^2/\varepsilon r^2 l_1 \tag{3}$$