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Resonance properties of split ring resonators made of polyaniline based conducting polymer

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Abstract We present the observance of magnetic resonance for the first time in split ring resonators (SRR's) made of polyaniline based conducting polymer and verify our experimental result through simulation. The magnetic resonance behaviour of closed ring resonator (CRR) and SRR of polyaniline - polytetrafluoroethylene (Pani - PTFE) are studied for square and circular shaped rings. This humidity sensitive conducting Pani - PTFE ring, the main characteristics of our novel resonance structure, behaves like lossy conducting ring with wide band resonance behavior whereas the CRR doesnot show any resonant response as is expected for a metallic ring. The results are compared using simulation studies of copper rings of similar dimensions. Resonance absorption of the Pani - PTFE ring resonators are analyzed using the transimission spectra (S_{21}) obtained by arranging the proposed resonator between monopole antennas connected to the transmitting and receiving probes of a Vector Network Analyzer (VNA). The humidity dependence and flexibility of this Pani - PTFE ring can be used for the designing of frequency tunable 3 dimensional resonator and sensors at microwave regime.

Keywords Polyaniline · conducting polymer · split ring resonator · magnetic resonance

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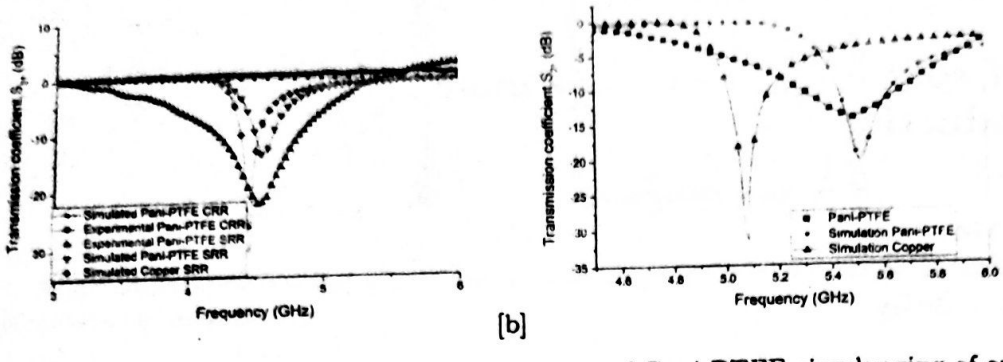

[a] [b]

Fig. 1 (a) Magnetic resonances present in a Copper and Pani-PTFE circular ring of outer diameter = 10 mm, inner diameter = 8 mm, slit = 1.057 mm and thickness t = 2 mm .(b) Magnetic resonances present in a Copper and Pani-PTFE square ring of outer length l_{outer} = 10 mm, inner length l_{inner} = 3.8 mm, split s = 3 mm and thickness t = 1.5 mm.

Protonated chlorine doped polyanilie (Pani) is formed from aniline and ammonium peroxysulphate (APS) using chemical oxidation method. The powdered polyaniline is then turned into sheet form using polytetrafluoroethylene (PTFE) so as to form polyaniline - polytetrafluoroethylene (Pani-PTFE) hybrid sheet.[1,2]The prepared sheets possessing greater conductivity in highly humid conditions are then cut into square and circular rings of specific dimensions.

Figure 1(a) shows the experimental magnetic resonance curves obtained for SRR and CRR of circular geometry made of Pani - PTFE along with the simulation results. Simulated result of circular copper ring with same dimension is also shown in the figure for comparison. The wide band resonance behavior of the Pani - PTFE ring in comparison with its metallic counter part is due to the lower conductivity of the material. The absence of magnetic resonance for CRR is also noticed.[3,4] Figure 1(b) shows the experimental magnetic resonance spectra of a square SRR along with the simulation results where the simulated curve of square metallic ring is also shown. The noticeable shift in the resonance frequency between Pani - PTFE and copper ring may be explained in terms of the higher contribution of displacement current due to the nonignorable dielectric behavior of Pani - PTFE material. The magnetic response of this polymer with tunable conductivity makes it a new candidate for the realisation of left handed materials with attractive features.

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