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High Sensitive Mechanical Vibration Sensor using Triangular BCSRR

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Abstract This paper introduces a novel Triangular Broadside Coupled Split Ring Resonator (TBCSRR) metamaterial structure with high Quality factor for the sensitive detection of very weak mechanical vibrations. Instead of fabricating TBCSRR in a conventional manner, we have fixed metallic triangular strips of the resonator on two separate identical low loss thin sheets coaxially, which are capable of changing the spacing between them. Vibration sensor operates on the possible resonance frequency variations of the TBCSRR in relation to the changes in the spacing between rings caused due to amplitude of mechanical vibrations. If the operating frequency of the TBCSRR is selected on the rising or falling slope of the resonance curve, the output amplitude fluctuates in accordance with mechanical vibrations. The resonant absorption curve having very small bandwidth, not reported for earlier structures, makes the proposed TBCSRR a suitable choice for high sensitive vibration measurements. The high Q resonance curve of TBCSRR is experimentally obtained and the result is confirmed using simulation. Using TBCSRR as a sensor probe the amplitude variations caused due to some typical vibrations are presented. The proposed TBCSRR sensor probe may find applications in detecting even very weak vibrations caused due to various man-made and natural sources.

Keywords Metamaterials · Vibration Sensor · BCSRR

Metamaterial TBCSRR structure of different dimensions are fabricated and resonance properties are studied. Fig 1a shows the schematic representation of TBCSRR and Fig 1b shows the experimental and simulated resonance curves

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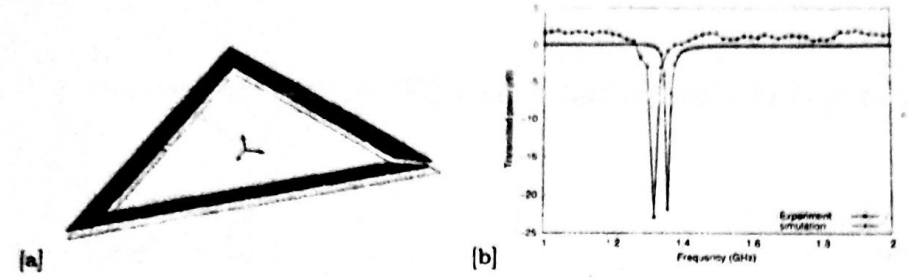

Fig. 1 a) Design of Triangular BCSRR b) Transmission spectra of Triangular BCSRR.

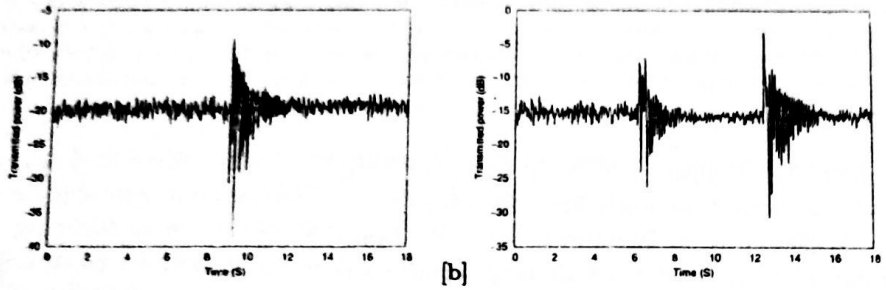

Fig. 2 a) Output vibration pattern due to freely falling standard weight of 2 gm from a height of 10 cm at a distance of 10 cm from the sensor probe. b) Output vibration pattern due to freely falling standard weight of 50 gm and 100 gm from a height of 25 cm at a distance of 2 m from the sensor probe.

of TBCRR having dimensions of length of one side 12 mm ,width 2 mm, silt width 0.5 mm, thickness 0.05 mm and spacing 0.5mm. The experimental set up consists of the newly designed TBCSRR unit with one of its triangular portion fixed on a rigid support whereas the other one is mounted coaxially on a cantilever capable of sensing mechanical vibrations, placed between transmitting and receiving probes of Vector Network Analyser[1,2].

Operating point for the vibration sensor is chosen on the falling edge of the absorption curve at a frequency of 1.31 GHz . In order to verify the sensitivity of the proposed vibration sensor, we have measured vibrations caused due to freely falling standard weights. Typical vibration patterns are shown in Fig 2a and 2b. This proposed high sensitive TBCSRR based vibration sensor can be a suitable choice for the precise detection of very weak vibrations like seismic tremors, vibrations due to hectic transportations, quarrying, pilling etc.

References

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