Left-handed metamaterial based on circular split ring (CSRR) resonator for microwave sensing Application	
Authors	**SM Anowarul Haque, MT Islam, Ismail Hossain, Fawzi Alorifi, Zaid Ahmed Shamsan, Khalid Almuhanna, Sharul Kamal Abdul Rahim, Md Samsuzzaman**
Publication Year	2024
Grant Number	IMSIU-RG23095
DOI link	10.1016/j.optmat.2024.115480

Abstract: This paper presents a new metamaterial structure specifically designed to operate in the L, S, and C frequency bands. It is characterized by a small unit cell size of 15mm × 15 mm. The metamaterial's electromagnetic properties are thoroughly examined, utilizing FR-4 substrate material and copper circular split ring resonators (CSRRs). The Computer Simulation Technology (CST) software uses the finite integration technique (FIT) to precisely model the effective parameters over a frequency range of 0–6 GHz. In simulations and experiments, the structure demonstrates negative refractive index, effective permittivity, and effective permeability. The electric and magnetic field distributions within the unit cell are accurately characterized using vector fields. In addition, the equivalent circuit is simulated and depicted using ADS software, with comparisons drawn between the measured data and the simulated data. The experimental validation, conducted using six varying thicknesses of FR4 materials, verifies the resemblance between the simulated and the measured transmission coefficients. Moreover, the effective medium ratio (EMR) of the metamaterial is calculated to be 12.74, indicating its promising capabilities for microwave sensing applications. The examination of the sensor model uncovers such metrics as quality factors, frequency detection resolution (FDR) values, and sensitivities, all of which enhance our comprehension of the material's performance. This discovery has the potential to advance the development of sensing metamaterials, which could significantly impact various applications and enhance research in the field.

هـ-خوجه