Soft Computing for Terahertz Metamaterial Absorber Design for Biomedical Application

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Abstract The terahertz region of the electromagnetic spectrum plays a vital role in biomedical imaging due to its sensitivity to vibrational modes of biomolecules. Biomedical imaging may be used to distinguish between the infected (cancer) and the non-infected tissues (A.J.F. Fitzgerald, V.P. Wallace, M. Jimenez-Linan, L. Bobrow, R. J. Pye, A.D. Purushotham, and D. D. Arnone, *Radiology*, May 2006), which requires broad band and highly efficient radar absorbing material (RAM) designs to obtain high resolution image of the tissues.

In this paper, a novel RAM design with high efficiency over the required wideband is presented. The performance is enhanced considerably by introducing an optimized metamaterial split ring resonator (SRR). Such an application requires design of metamaterial structures for a desired frequency range (equivalent to the operational frequency of the RAM design). A particle swarm optimization (PSO) algorithm is developed here, which optimizes the resonant frequency and provides the structural parameters. This optimized design is further used as one of the layers of RAM design. The resulting optimized structure provides a near unity absorption within the required wideband frequency range.

The RAM design presented here consists of 4 layers. The layers are composed of a metallic (gold) layer adjacent to a dielectric spacer layer. The thickness of the gold layer is 0.4 μm, and that of the dielectric spacer is 8 μm. The gold layer is sandwiched between the dielectric spacer made up of polymide. The conductivity of the gold layer is 4.09×10^{7} s/m. The permittivity of the polyimide layer is 2.8814, and permeability is unity. The top layer made of gold is an array of SRR structure (metamaterial). The SRR structure designed here contains inductances and capacitances. The linear bars act as inductive elements whereas the gaps act as capacitive elements, which contribute to the permittivity and permeability of the structure.

The optimized square SRR is introduced as the top layer of the RAM design. The scattering parameters of the designed structure are extracted and used for calculation of absorption. It is observed that the absorption is above 99.32 % at 1.16 THz, which is sufficient for biomedical spectroscopy applications.

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