Abstract

Now a days, the electromagnetic interference shielding (EMI) materials have great applications in defense, electronics, commerce and industry. In this regard, the hexaferrites and their composites having high microwave absorbing capability are widely being utilized to address the tough EMI problem. The present work is focused on the synthesis of hexaferrite composites by using a chemical route. Different variations like substitutions by metal ions and mixing of polymers like Polyether Ether Ketone (PEEK) and Reduced graphene oxide (RGO) have been employed in hexaferrite to improve microwave absorption properties. The microwave absorption is measured in frequency region of 8.2 to 12.4 GHz (X-band).

A brief overview of the performed experiment is given as follows:-

In the **first experiment**, M-type hexaferrite composites based on $Ba_{0.8}Gd_{0.2}Fe_{11.5}Co_{0.5}O_{19}$ (BaM) and polyether ether ketone (PEEK) have been investigated for X-band applications. Composites with hexaferrite to PEEK ratios 5:0, 4:1, 3:2, 2:3, 1:4, 0:5 have been synthesized by a micro-emulsion method. XRD results confirm the hexagonal structure of the hexaferrite with an average crystallite size up to 37.2 nm. Magnetic properties reveal that saturation magnetization Ms increases whereas coercivity Hc decreases by increasing the ferrite content in the composites. Complex permittivity and permeability have been tailored with ferrite content in the X-band. Both the real permittivity and permeability decreases by decreasing the ferrite concentration in PEEK. The microwave results show the minimum reflection loss of − 10.79 dB for composite with 80% ferrite.

In the **2nd experiment**, M-type $SrFe_{11}CoO_{12}$ (SrM) hexaferrite nanocomposites based on SrM/PEEK in ratio 4:0, 3:1, 2:2 and 0:4 were prepared by employing the micro-emulsion method. The composites were further characterized using XRD, SEM, FTIR and VNA. XRD results exhibited a single-phase hexaferrite structure. FESEM micrographs revealed surface morphology and nature of the grains in the prepared nanocomposites. EDAX plots showed the presence of the constituent elements e.g., Fe, Sr, C and O, at the respective standard energies. FTIR spectra of SrM depicted the formation of hexaferrite due to the presence of Fe-O stretching peak at 525 cm^{-1}. Hysterisis loops show the

ferromagnetic nature of SrM and its composites. By increasing ferrite content in composites, saturation magnetization M_s increases while coercivity H_c decreases. Reflection loss was found to decrease due to increasing ferrite concentration in PEEK. A minimum reflection loss of -11.5 dB is obtained for the composite having ferrite:PEEK as 3:1. The reflection loss <-10 dB indicates that SrM/PEEK composites are potential microwave absorbers for microwave applications in the X band.

In the **third experiment**, a lightweight and flexible microwave absorber composite was fabricated using W-type barium hexaferrite $Ba_{0.9}La_{0.10}Co_2Fe_{16}O_{27}$ (BaW), reduced graphene oxide (RGO) and polyvinylidene fluoride (PVDF). W-type hexaferrite nanoparticles (BaW) were fabricated by the sol-gel auto-combustion method. The synthesized nanoparticles were mixed in PVDF and RGO through ultrasonication. The prepared samples were characterized through different techniques for their structural, morphological, and EM properties, as discussed in detail. The X-ray diffractometer results showed the existence of a single-phase hexaferrite structure with an average particle size of 48.9 nm. The scanning electron microscope results show that BaW/PVDF is completely embedded in RGO. Dielectric results showed that the addition of RGO in BaW/PVDF increases the polarization effect, which increases the dielectric constant of the material. Moreover, RGO decreases the saturation magnetization of composites, which increases the anisotropy constant and hence increases the magnetic loss of material. The composite C3 having RGO to ferrite ratio 15:100 exhibits the minimum reflection loss of -10.8 dB with broad bandwidth <-10 dB for complete X-band (8.2–12.4 GHz)