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Exchange-coupled hard-soft ferrites; A new microwave material

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Abstract

During the past decade, hexaferrite has become an important candidate for a variety of microwave and millimeter-wave devices due to their large uniaxial magneto-crystalline anisotropy and high saturation magnetization. The goal of this investigation is to synthesize $BaFe_{12}O_{19}/Y_3Fe_5O_{12}$ (Barium hexaferrite/Yttrium Iron Garnet - BaM/YIG) hard-soft ferrite nanocomposites (NCs) as an advanced microwave material. A detailed microstructure and magnetic properties of these nano-composites were investigated using various techniques; viz. X-ray diffractometry (XRD), vibrating sample magnetometry (VSM), Raman spectroscopy, scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

With recent advances in nanostructure synthesis techniques, we have realized a thin nano-composite layer on top of coplanar waveguide (CPW) planar transmission lines to design microwave notch-filters. Using a vector network analyzer we have checked the device operation from X- to Ka-band through ferromagnetic resonance (FMR) spectroscopy. The FMR linewidth (device bandwidth) is observed to be tunable with $(BaM)_{1-x}(YIG)_x$ nanocomposite from 2 kOe (900 MHz) for pure BaM (x=0) to 0.2 kOe (90 MHz) for pure YIG (x=1). Various mathematical models were employed to fit the experimentally observed FMR linewidth (ΔH) data to yield intrinsic and extrinsic damping parameters as a function of 'x' value in $(BaM)_{1-x}(YIG)_x$ nanocomposite.

Keywords: Barium hexaferrite (BaM), Yttrium Iron Garnet (YIG), BaM/YIG nanocomposite, magnetic property, microwave absorption, Notch filter.