Magnonic-photonic Crystals with Application to Tunable Microwave Devices

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Magnonic and magneto-photonic crystals based on magnetic materials have become a field of increasing interest in recent years. One- and two-dimensional (1-D and 2-D) periodic layer structures can be engineered by varying the magnetic properties such as magnetization and anisotropy using magnetic-non-magnetic, all-magnetic, ferro- and anti-ferromagnetic lattices. A variety of tunable microwave and magnetooptic devices based on propagation of magnetostatic (or spin) waves in such magnonic and magneto-photonic crystals can be envisaged.

In this work, the dispersion and bandgap characteristics of magnetostatic waves propagating in 1- and 2-D magnonic and magneto-photonic crystals are first formulated using Maxwell's and Landau-Lifshitz equations. Specifically, the 2-D periodic structure with magnetization inhomogeneity facilitated by creating 2-D array of holes in yttrium iron garnet (YIG) ferromagnetic thin films are analyzed in detail. The resulting dispersion characteristics depend on the periodicity and depth of the holes as well as the bias magnetic field. The corresponding experimental studies were carried out at the frequencny range of 2.0 to 6.0 GHz. The measured dispersion characteristics of the magnetostatic waves show magnetic field-dependent bandgaps. Such magnetically-tunable frequency bandgaps should facilitate control and processing of microwaves. The findings of both theoretical and experimental studies will be presented.

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