ELECTROMAGNETIC BANDGAP STRUCTURES AT OPTCAL FREQUENCIES AND THEIR APPLICATIONS

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In the past few years, there has been increasing interest in using electromagnetic bandgap (EBG) structures and their finite realizations to develop materials that exhibit novel material and device responses. Artificial dielectrics were explored, for example, in the 1950's and 1960's for light-weight microwave antenna lenses. Artificial chiral materials were investigated in the 1980's and 1990's for microwave radar absorber applications. Recent examples of these artificial material activities include photonic band gap (PBG) structured materials in one, two and three dimensions, and metamaterials, including double negative (DNG) materials that exhibit positive or negative permittivity or permeability properties. Very recent experiments involving metamaterials have demonstrated the existence of the DNG media. Several involving EBG structures have demonstrated novel device potentials, for example, the superprism effects. Moreover, the EBG structures in the photonics regime have led to nanometer-sized optical waveguides; at microwave frequencies they have been used to develop reconfigurable cavity resonance and free space propagation frequency filters.

A basic review of these optical EBG structures and their applications to waveguides, filters, power splitters and other devices will be given. Simulation and experimental results will be used to demonstrate the large potential for novel applications of these optical EBG structures in the micron and nanometer regimes. Emphasis will be given to defects in optical EBG structures and the physical effects obtained with them.

The qualitatively new response functions of metamaterials are often generated by artificially fabricated, extrinsic, low dimensional inhomogeneities. Inclusions such a capacitively load strips and split ring resonators have been used to realize DNG media at X-band frequencies. We will report similar simulations results at optical frequencies and indicate the potential for the realization of optical DNG media and their potential applications for phase front modifications and enhanced focusing.