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Invited

Metallic and Dielectric Photonic Crystals for Photon Control

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A Photonic Crystal is an artificial 3-dimensional dielectric structure which does to photons as a semiconductor crystal does to electrons; it produces a forbidden photonic band gap, a band of frequencies in which spontaneous emission and zero-point electro-magnetic field fluctuations are forbidden.

We have now begun to investigate metallic rather than dielectric photonic crystals. We have tested a metallic photonic crystal consisting of 3-dimensional wire mesh in the geometry of covalently bonded diamond. Since metals have an important dissipative component in their dielectric constant, their photonic crystal electrodynamics cannot be reduced to a Hermitian eignenvalue problem.

Our experimental results show three new features which we did not expect: (a) Metallic photonic crystals have forbidden bands at those frequencies corresponding to the lattice spacing, just as dielectric photonic crystals do. (b) In addition, they have a new forbidden band which commences at zero frequency, and extends to approximately half the normal bandgap frequency. (c) Longitudinal modes are allowed in metallic photonic crystals. Therefore the electromagnetic waves have three possible polarizations, rather than just two!

We will discuss the application of metallic photonic crystals to solid-state electronics and to microwave engineering.