Diamagnetic Response of Metallic Photonic Crystals at Infrared and Visible Frequencies

Xinhua Hu,[1] C. T. Chan,[2] Jian Zi,[3] Ming Li,[1] Zhuo Ye,[1] and Kai-Ming Ho[1]
[1]Ames Laboratory and Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA
[2]Department of Physics, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China
[3]Surface Physics Laboratory (National Key Lab), Fudan University, Shanghai 200433, People's Republic of China

We show analytically and numerically that diamagnetic response (effective magnetic permeability $\mu_e<1$) at infrared and visible frequencies can be achieved in photonic crystals composed of metallic nanowires or nanospheres when the wavelength λ is much larger than the lattice constant a (λ~2000a). When λ~100a, the metallic photonic crystals will exhibit strong diamagnetic response ($\mu_e<0.8$), leading to many interesting phenomena such as the unusual Brewster angle for s waves and incident-angle-and-polarization-independent reflection and transmission.

Based on the Brewster angle phenomenon of p waves in rectangular arrays of metallic nanowires, we propose a polarization beam splitter which can completely separate the p and s waves at an incident angle of $45^0 \pm 10^0$ in a very wide wavelength range (1~500μm).

[1] X. Hu, C. T. Chan, J. Zi, M. Li, and K. M. Ho, Phys. Rev. Lett. 96, 223901 (2006).
[2] X. Hu and K. M. Ho, Appl. Phys. Lett. 89, 201906 (2006).