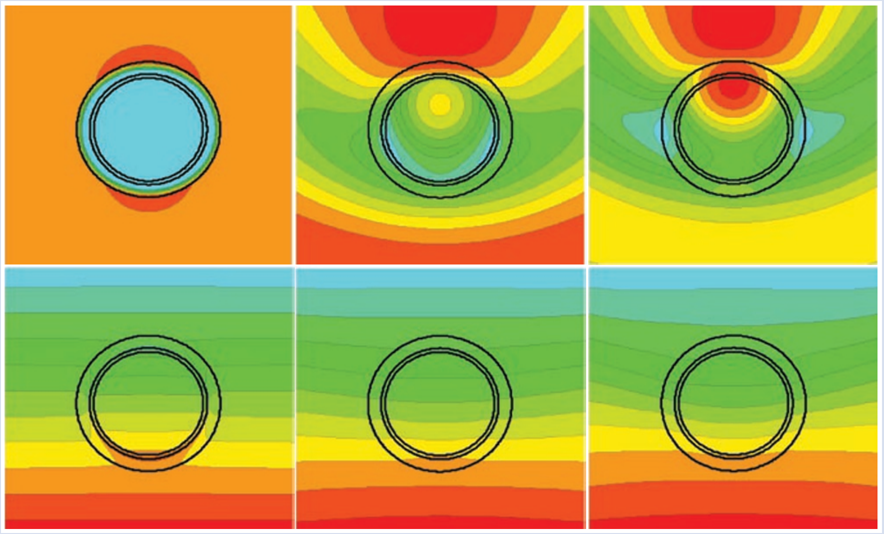
OPTICAL CLOAKING

A many-layered solution



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The idea of optical cloaking is intriguing and has captured the imagination of both scientists and the general public. In 2005, Andrea Alù and Nader Engheta came up with the idea of using plasmonic and metamaterial 'cloaks' to reduce the scattering properties of objects and thereby render them 'invisible' at particular frequencies. Now they have gone further, suggesting that a multilayered plasmonic shell could be used to cloak an object at several different optical frequencies all at the same time (*Phys. Rev. Lett.* **100,** 113901; 2008).

Most cloaking techniques can reduce the visibility of an object at one frequency only. The original scattering cancellation technique proposed by Alù and Engheta was limited to a single frequency range because, for various technical reasons, plasmonic materials and metamaterials with low or negative permittivity values (which is key to the cloaking mechanism) are required to be dispersive. Now the researchers show that it is possible to exploit a plasmonic material's frequency dispersion to achieve multiple-frequency cloaking.

To do this they use a multilayered plasmonic cloak to cover the dielectric or conducting object. They apply Mie scattering theory to a many-layered spherical object and come up with equations that describe the total scattering from the cloaked system. By having several cloaking layers instead of just one, each of which is designed to yield plasmonic behaviour in a different frequency window, Alù and Engheta show that the overall scattering from a covered object can be suppressed simultaneously at distinct frequencies. They demonstrate their approach by designing a two-layered cloak that can make a 200-nm-diameter nanoparticle simultaneously invisible at wavelengths of 500 nm and 625 nm. They expect extension of this technique to more layers (and therefore more cloaking frequencies) will be straightforward.

At this stage the findings are only theoretical, and the total number of layers that can be used will depend on scientists' ability to construct thin concentric layers while keeping the total size of the cloaked system to a minimum (to avoid exciting higher-order scattering harmonics). The authors say that simultaneous cloaking at different frequencies is within the realm of current nanotechnology. Now it is up to experimentalists to prove them right.

Amber Jenkins

PLASMONICS

Engineering optical nanoantennas

Optical antennas are the short-wavelength equivalent of the common radiofrequency structures. Taking this analogy one step further, the design concepts of radiofrequency lumped circuit elements can effectively be transplanted to optical wavelengths.

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The development of advanced optical structures has enabled tremendous levels of control over the propagation and manipulation of light waves. This control is used in many technological applications, including optical microscopy, solar cells and efficient solid-state light sources, and it has also become important in biotechnology, medicine and the modern-day telecommunications industry. Until recently, it was thought that the manipulation of light was limited by the fundamental laws of diffraction to relatively large, wavelength-scale (about 0.5 μm) components; this is all about to change.

Plasmonics is an exploding field of science and technology in which the flow of light can be moulded at the nanoscale using metallic nanostructures[1]. A myriad plasmonic components have been designed to concentrate light at the nanoscale[2], to produce perfect lenses[3] and hyperlenses[4] that enable imaging of objects at subdiffraction-limit scales, and to transport electromagnetic energy over short distances with nanoscale