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Light-amplifying resin boosts invisibility cloaks

12:00 05 August 2010 by [Colin Barras](#)

Metamaterials can bend light around objects to render them near-invisible, but they absorb so much light in the process that objects cannot be flawlessly disguised – they are revealed by the dimness of the metamaterial.

[Vladimir Shalaev](#) at Purdue University in West Lafayette, Indiana, thinks he has a solution that could help the exotic materials find their way into real-world applications.

His team began with a metamaterial comprised of two layers of silver separated by insulating aluminium oxide. The horizontally layered material is perforated by vertical nanoscopic holes, giving it a fishnet-like structure – and its light-bending properties. But the silver absorbs up to 60 per cent of the incoming light, resulting in a visibly dimmed output.

The team realised that they could compensate for those severe losses by replacing the aluminium oxide with a "gain" material – resin doped with a dye called rhodamine 800. When hit by an infrared laser pulse, the dye's electrons are excited and respond to visible light passing through the metamaterial by creating more photons – a process called stimulated emission.

Magnetic assistance

"We can't use too much of the gain material because it has a positive refractive index which could 'kill' the negative index of the original sample," says Shalaev. That would mean losing the very light-bending properties they are seeking to preserve and improve.

Fortunately, because the production process involves adding the dye between the metal layers, where the electromagnetic fields are stronger than in free space, the gain process is roughly 50 times more efficient and so less gain material is required, he says. "Without taking advantage of the high local fields we probably wouldn't be able to compensate the large losses [of light] from the metal components."

Tests showed that visible red light with a wavelength of 720 to 740 nanometres passes through the metamaterial without loss. Quite the reverse, in fact. "We overcompensated", says Shalaev – the doped metamaterial emitted more visible light than was shone onto it. That should be reasonably straightforward to adjust, creating perfect invisibility for specific wavelengths. "The most important result of our work," he says is that "we have a negative-index metamaterial" that doesn't absorb too much light.

[Ulf Leonhardt](#), a metamaterial researcher at the University of St Andrews in the UK, says the result is a "tremendous achievement". "They have been working for years to make it happen," he adds.

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