

Invisibility cloak takes one step closer to revealing itself

August 7 2017, by Benedict O'donnell, From Horizon Magazine



Scientists try to beat nature at the camouflage game by bending light. Credit: Kdsphotos / Pixabay

Two research teams have made structures that could help conceal objects from daylight – taking the next step towards making the visible,

invisible. Recent progress draws on advances in so-called metamaterials, which are microscopic structures that bend light in unnatural directions.

Metamaterials have already managed to reroute microwaves, infrared radiation and, given the right circumstances, visible colours, so that they go around metal obstacles and living creatures.

'These experiments have demonstrated the underlying physics of a cloaking device,' said Professor Costas Soukoulis from the Foundation for Research and Technology in Heraklion, Greece, who is also working to develop this technology through a research project called PHOTOMETA, funded by the EU's European Research Council (ERC).

But Prof. Soukoulis acknowledged that existing invisibility cloaks still fall short of the standards set by Perseus or Harry Potter and said that 'most metamaterials still struggle to bend light that is visible to the naked eye'.

An additional shortcoming is the tendency of metamaterials to absorb part of the light that shines through them, which casts a recognisable shadow. Most are also cumbersome to carry and impractical to manufacture.

However, Dr Patrice Genevet from the CRHEA research centre in Valbonne, France, is hoping to address these challenges by using light materials and visual techniques from the electronic display industry.

As part of his ERC-funded research, FLATLIGHT, Dr Genevet is coating flat lenses with skin-thin layers of gallium nitride, the material that emits blue light in LED displays.

The gallium nitride is then carved into pillars that are small enough to create delays in how light waves flow through them. Having studied how

different-shaped pillars distort light, Dr Genevet can now design lenses that force light in any direction, looping it sideways or backwards on demand.

All metamaterials can pull off similar feats, but electronic materials like gallium nitride are unusual in that they do so with visible light. The material's properties provide the potential of someday developing a real-life cloaking device.

'If you want to bend light around sharp angles, you have to use materials that cannot be found in nature,' said Dr Genevet.

While conventional metamaterials tend to be ill-suited for moving around unnoticed, Dr Genevet fashions his pillars in thin layers that could, in principle, be deposited on flexible surfaces and incorporated into stealth suits.

He has also reduced light absorption by optimising the design of his pillars, increasing the optical transmission of his flat lenses from 60 % to almost 90 %, and is now investigating whether gallium nitride can replace the remaining losses by emitting light of its own.

These refinements are at an early stage of development, but the technology is already finding applications in other markets where weight is an expense.

For example, on board the European Space Agency's space observatory, the Gaia spacecraft uses similar materials in its efforts to split light and help measure the composition of stars more precisely.

Dr Genevet expects that working with established techniques will ultimately make it possible to mass-produce [flat lenses](#) more economically than the three-dimensional metamaterials available today.

Camouflage

For all their merit, [gallium nitride](#) pillars share one design flaw with most other metamaterials. Each array of pillars only works within a narrow range of colours, meaning that the object it cloaks remains visible in all others.

Meanwhile, Prof. Soukoulis is working on strategic solutions to fundamental questions of this nature. Earlier this year, he revealed a strontium-titanium alloy that changes the frequency of light and can guide it depending on the ambient temperature.

'This chameleon approach would still only cloak an object to one colour at a time, but we could pick that colour on demand,' he said.

Given the current pace of progress, Prof. Soukoulis is convinced that ongoing research into cloaking devices will continue to surmount technical hurdles, but he is excited by what discoveries may arise along the way.

'Using the same techniques, [metamaterials](#) could guide light around sensitive organs during laser surgery, and collect signals from sources as faint as live viruses,' said Prof. Soukoulis.

Provided by Horizon: The EU Research & Innovation Magazine

Citation: Invisibility cloak takes one step closer to revealing itself (2017, August 7) retrieved 4 February 2023 from <https://phys.org/news/2017-08-invisibility-cloak-closer-revealing.html>

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