Breakthrough Made in Metamaterial Optics

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(PhysOrg.com) -- Researchers have solved one of the significant remaining challenges with photonic “metamaterials,” discovering a way to prevent the loss of light as it passes through these materials, and opening the door to many important new optical, electronic and communication technologies.

The advance, made by scientists from Oregon State University and Norfolk State University, was just published in *Physical Review Letters*.

“The ability to compensate for optical loss is a very large step forward for the whole field of active plasmonics,” said Viktor Podolskiy, an OSU assistant professor of physics. “Some of the most important potential applications in this field have been held back by this problem.”

These “metamaterials,” which gain their properties from their structure rather than directly from their composition, have been seen as a key to a possible “super lens” that would have an extraordinary level of resolution and be able to “see” things the size of a nanometer - a human hair is 100,000 nanometers wide.

They could also be important in machine visions systems, electronics manufacturing, computers limited only by the speed of light, and a range of new communications concepts. A “cloaking device” to hide objects, although not exactly of the type made famous by Star Trek, is also a possibility.

“This is a significant breakthrough,” said Mikhail Noginov, professor in

the Department of Physics and the Center for Materials Research at Norfolk State University in Norfolk, Va. “Many of the fantastic possible applications of these materials have been largely prevented by the obstacle of the absorption loss. That’s a big problem that we should now be able to work past.”

Photonic metamaterials are engineered composite materials with unique electromagnetic properties, and have attracted significant research interest in recent years due to their potential to create “negative index” materials that bend light the opposite way of anything found in the natural world. But their performance has been significantly limited by the absorption of light by metals that are part of their composition - metal might absorb much more than 50 percent of the light shined on it, and drastically reduce the performance of devices based on these materials.

The solution to this problem, researchers discovered, is to offset this lost light by adding an optical “gain” to a dielectric adjacent to the metal. The new publication outlines how to successfully do that, and demonstrates the ability to completely compensate for lost light. It had been theorized that this might be possible, the researchers said, but it had never before been done, and the theories themselves were the subject of much scientific debate.

As such, this may have removed a final roadblock and now made possible “a number of dreamed about applications,” Podolskiy said.

“Our work proves that the compensation of surface plasmon polariton loss by gain is indeed possible, opening the road for many practical applications of nanoplasmonics and metamaterials,” the researchers wrote in their study. “Besides resolving of the fundamental limitations of modern nanoplasmonics, the observed phenomenon adds a new emission source to the toolbox of active optical metamaterials.”