Surface plasmons enhance nanostructure possibilities

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As technology becomes smaller and smaller, scientists work to find solutions to a variety of problems in many different fields. It is known that light could be used for studying molecules and atoms, as well as for solving problems of quantum information processing and even for lab-on-chip applications in biology. The problem is how to reduce size of such optical devices to the level compatible with modern nanotechnology.

A group of scientists from University College London and at the Queen's University of Belfast have demonstrated a principle of achieving ultrahigh light dispersion that makes use of surface plasmon polaritons on nanostructures.

"We have proposed a new principle to realize a microscale spectral device using the properties of surface plasmons on metallic nanostructures that can provide wavelength separation of one or more orders of magnitude better than in other state-of-the-art wavelength-splitting devices available to date," Anatoly Zayats, one of the scientists at Queen's University, tells *PhysOrg.com* via email. He and his colleagues have published their process, and the results of their experiment, in a *Physical Review Letters* piece: "Dispersing Light with Surface Plasmon Polaritonic Crystals."

Zayats points out that using conventional light diffraction can be difficult in optical communications and other systems because bulk three dimensional grating. "It is not possible to have several next to each other because of the size," he says via phone.

This problem is solved by the use of surface plasmon polaritons (SPPs). The SPPs used in the demonstration by the group from University College and Queen's University are on a periodic nanostructure. In this realization, the dispersion process has two stages: the first changes incident light into SPP Bloch modes and the second involves refraction of the SPP Bloch waves. A metallic nanostructure both excites and diffracts the SPPs. Zayats says, "This significantly enhances the dispersion through the combination of conventional diffraction, amplified by the photonic superprism-like effect."

Uses for the plasmonic light dispersion would be in such areas as quantum information processing, lab-on-chip applications (especially in biology) for spectral analysis, chemistry and electronic engineering. Additionally, the high-resolution capabilities of this novel technique would allow for further study in fundamental physics. The Group is most excited about the implications for optical communications as signal processing devices.

Zayats insists that the process is compatible with current technologies. The development and testing of the technique illustrates that it is possible with today's scientific capabilities. However, he continues, using this SPP nanostructure technology "would require some work to interface conventional photonic devices and the proposed plasmonic device." Zayats says that even though it is possible to achieve this, the difficulty is efficiently integrating it with current practical technology. "Interfacing is the problem that plasmonic in general is currently facing."

But Zayats remains optimistic that the system he and his colleagues have worked out will be viable. He maintains that there are several methods in the works by different scientific groups with regard to solving the problem of plasmonic integration: "As soon as this will be resolved to everyone's satisfaction, we will most definitely see the dispersion plasmonic device widely employed in standard optical communications."

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