Experimental demonstration of light scattering controlled by silicon nanoparticles

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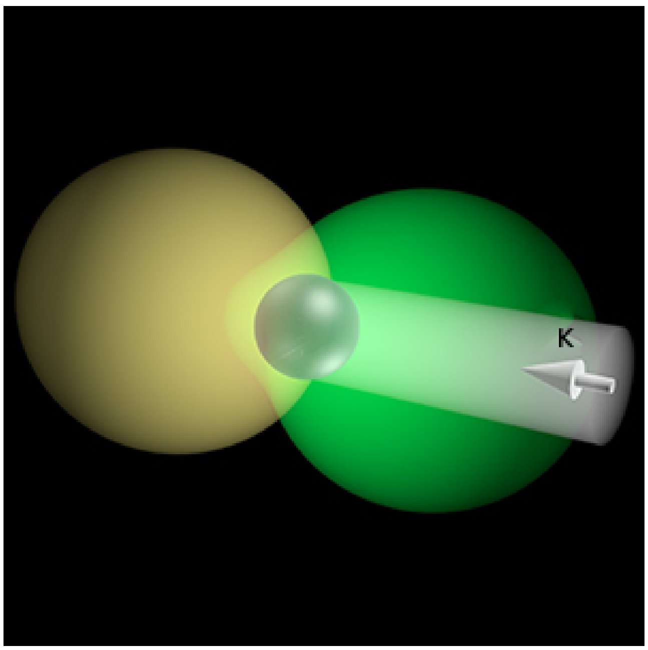

Researchers can make a single silicon nanoparticle forward- or backward-scatter different colors of light, as shown in the direction denoted by ‘K’. Credit: 2013 A*STAR Data Storage Institute

Optical fibers are now delivering ultrafast internet connections to homes across the world. By replacing electronics-based technologies with architectures that process pulses of light, a similar leap in speed might also be possible for other forms of information handling. To realize this potential, scientists must first develop novel devices that are capable of controlling the flow of light at the nanometer scale.

Such a device may now be within reach. Yuan Hsing Fu at the A*STAR Data Storage Institute and co?workers have demonstrated a unique optical effect in nanoparticles that allows them to control the direction in which visible light scatters.

Miniaturization is key to the success of modern-day electronics: complicated circuitry must be made to fit into portable devices. Likewise, the hardware for processing optical signals must also be miniaturized. In this field, known as photonics, the design of optical components requires an entirely new approach.

The effect demonstrated by Fu and co-workers reveals how nanoparticles can be used to scatter light controllably in the visible spectral range. The researchers first designed a method to measure the scattering, and then fired light at tiny spheres of silicon. When the beam hit a sphere, some scattered backward and some scattered forward. The researchers also showed that it is possible to control the ratio of movement in the two directions by changing the diameter of the nanosphere.

Using silicon spheres with diameters of between 100 and 200 nanometers, the team observed that the amount of forward-scattered light varied from being roughly equal to the amount that was backward-scattered to being six times more intense. They also found that the effect could split the light according to wavelength: for example, nanoparticles of a particular size that backscattered predominantly green light also forward scattered mainly yellow radiation (see image).

The researchers chose silicon over the more conventional choice of a metal such as gold because it reduces energy loss and can influence both the electric and magnetic components of light. The 'preferential' scattering of radiation arises because of the mutual interaction between the electric and magnetic resonances of the nanosphere.

This effect is analogous to that of a radio-frequency antenna. "The experimental proof of such relatively simple nano-optical systems with both an electric and magnetic response in the optical spectral range could pave the way to scaling the optical nano-antenna concept down to a single nanoparticle," says Fu. Optical nanoscale antennas could be useful for improving solar cells and might form a crucial building block for integrated optical circuits.

More information: Fu, Y. H., Kuznetsov, A. I., Miroshnichenko, A. E., Yu, Y. F. & Luk'yanchuk, B. Directional visible light scattering by silicon nanoparticles, *Nature Communications* 4, 1527 (2013). dx.doi.org/10.1038/ncomms2538

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