Nanocomposite material provides photonic switching

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(PhysOrg.com) -- Integrated photonic devices represent the wave of future technology. These devices will be extremely small, making use of photons on the nanoscale, and (hopefully) be very efficient in terms of power use. The development of integrated photonic devices in tomorrow's technology is taking place today at Peking University in Beijing, China, where a group of scientists has manufactured and tested a nanocomposite material that could be used in integrated photonic devices.

"There are many applications for this work," Qihuang Gong tells *PhysOrg.com*. Gong, along with his colleagues Xiaoyong Hu, Ping Jiang, Cheng Xin, Hong Yang, demonstrated a nano-Ag:polymer composite material can be used for photonic switching. Their work appears in *Applied Physics Letters*: "Nano-Ag:polymeric composite material for ultrafast photonic crystal all-optical switching."

"The nonacomposite material is composed of Ag nanoparticles dispersed in a MEH-PPV matrix," Gong explains. "MEH-PPV is a nonlinear organic conjugated polymer material." He points out that the nano-Ag:MEH-PPV composite has a large nonlinear susceptibility and very fast response time under resonant excitation, making it ideal for ultrafast optical switching applications. "Ultrafast response is maintained by use of a fast energy transfer process." The Chinese group found that it is possible to achieve a nonlinear response time of 35 ps.

In order to experiment with the nanocomposite material, the Peking University group employed a method of femtosecond pump and probe. The Ag nanoparticles, and the MEH-PPV molecules, were resonantly excited by a pump laser. During this process, energy is transferred from the MEH-PPV molecules to the Ag nanoparticles. A delay line was used to change the temporal relations between the pump and probe pulses. "Under the excitation of the pump laser," Gong explains, "the effective refractive index of the nano-Ag:MEH-PPV composite material changes, which leads to the changes of the photonic band gap and the transmittances of the probe laser." When this happens, the switching effect is realized.

Gong points out that this particular composite material is ideal for all-optical switching at fast speeds. "MEH-PPV possesses high environmental and thermal stability, high optical damage threshold, and good film quality," he says. Additionally, this material is easy to manufacture, and can be produced using current technology. Gong also notes that this nano-Ag:MEH-PPV composite material has very good waveguide properties. "This approach can be used in practical applications now."

There are limits to this nanocomposite material, Gong concedes. One of the main issues is that, "the organic polymer matrix can be damaged by a strong mechanical force." This means that the delicate material would need a certain level of careful handling in some cases. Gong also admits that the working wavelength is only about 800 nanometers. More study is needed, Gong says. "Our next steps are to study new approaches to achieving a large nonlinear susceptibility and a femtosecond nonlinear response time simultaneously."

By understanding how these composite materials work, it should be possible to create new materials that can provide a basis for smaller, more efficient devices.

More information: Xiaoyong Hu, et. al. "Nano-Ag:polymeric composite material for ultrafast photonic crystal all-optical switching." *Applied Physics Letters* (2009). Available online: link.aip.org/link/?APPLAB/94/031103/1