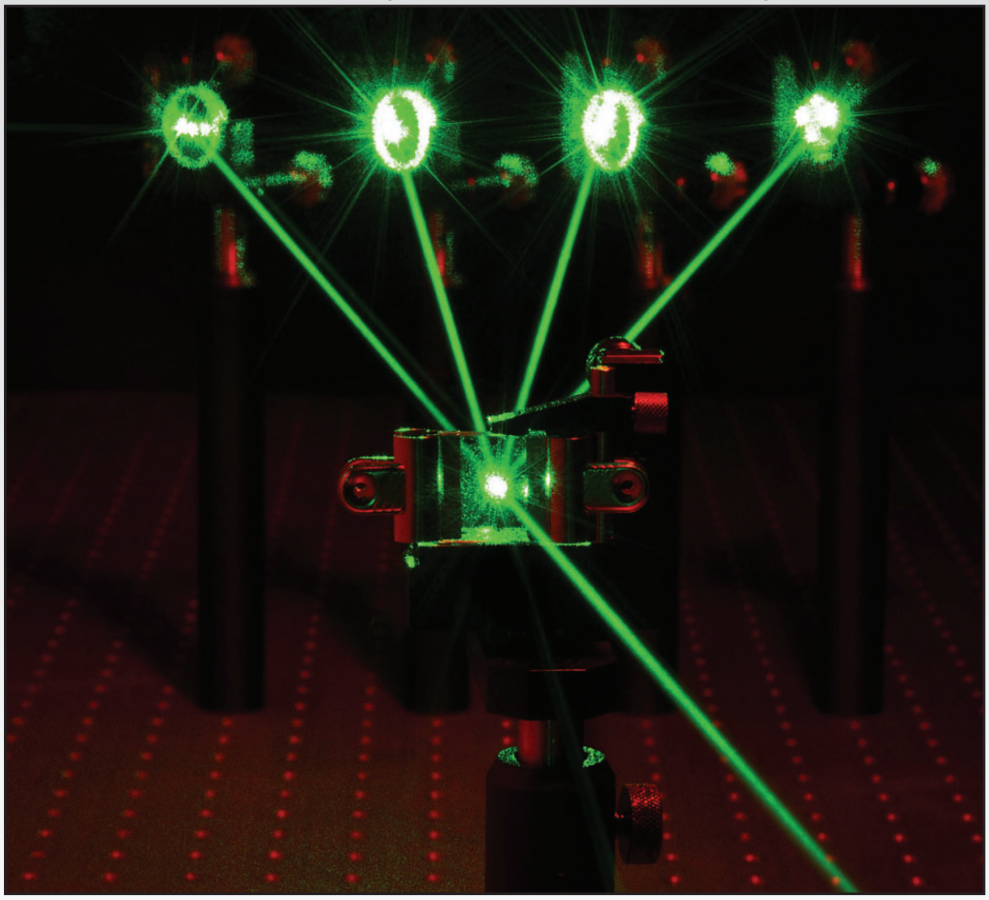
TECHNOLOGY MILESTONES

Ferroelectric Nanoparticle Discovery Greatly Enhances Optical Materials

AFRL researchers have developed the world's smallest ferroelectric nanoparticles. At less than ten nanometers in size, these materials, with enhanced ferroelectric properties, can be easily incorporated into a range of host materials with uses in photo-activated optical filters, liquid crystal displays, electrical energy harvesting and storage, metamaterials, and directed energy applications.

This discovery resulted in a dramatic improvement of the photorefractive effect in materials incorporating ferroelectric nanomaterials. The advancement will lead to new optical filter technologies and coherent beam combination methods for laser applications. It also has potential commercial applications in liquid crystal displays, improved materials for electrical energy storage, and new smart sensor technologies.

Ferroelectricity refers to the property of certain materials possessing a spontaneous polarization in which the electric dipole orientation can be controlled by an electric field. The influence of the electric field can have different effects, which are application specific. For beam coupling, the ferroelectric nanoparticles respond to electric torque, resulting in a more sensitive liquid crystal modulation. In liquid crystal display applications the nanoparticles create a voltage bias, thus reducing voltage requirements. In other applications, electrical or mechanical modulation of the dipoles leads to the generation of current.



Photorefractive beam coupling in a photorefractive organic-inorganic hybrid device: several laser beams entering a photorefractive hybrid cell resulting in a single combined (amplified) coherent beam. (AFRL Image)

As conventional nanoparticles are made smaller in size, they lose their ferroelectricity. AFRL researchers succeeded in overcoming this size dependence to make the world's smallest ferroelectric nanoparticles. This is because of the unique combination of fabrication methods developed in AFRL, which induces surface stress.

Because of a combination of nano-scale dimensions and enhanced ferroelectric properties, researchers have observed dramatic increases in the electro-optical properties of materials. Such an example can be found in photorefractive hybrid devices, where researchers have achieved world-record optical gain coefficients in photorefractive beam coupling through the incorporation of these nanoparticles. Similar technology has also created an 80 percent reduction in the voltage required to drive liquid crystal modulation, which is likely to dramatically reduce the energy requirements of liquid crystal displays. Other disparate potential applications include optical filters, electrical energy storage, and coherent beam amplification of directed energy.

The breakthrough methods pioneered by AFRL are likely to be transferable into other nanotechnologies, such as novel magnetic and multiferroic materials, creating new opportunities and a renaissance in nanometric ferroic material development.

For additional information on this technology contact AFRL/RX techinfo@afrl.af.mil, (937)255-6469. To receive more information about AFRL, visit the Homepage at www.wpafb.af.mil/afrl. (RX-11-34_08-29) ***Materials and Manufacturing/Discovery***

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