Organic crystals put laser focus on magnetism

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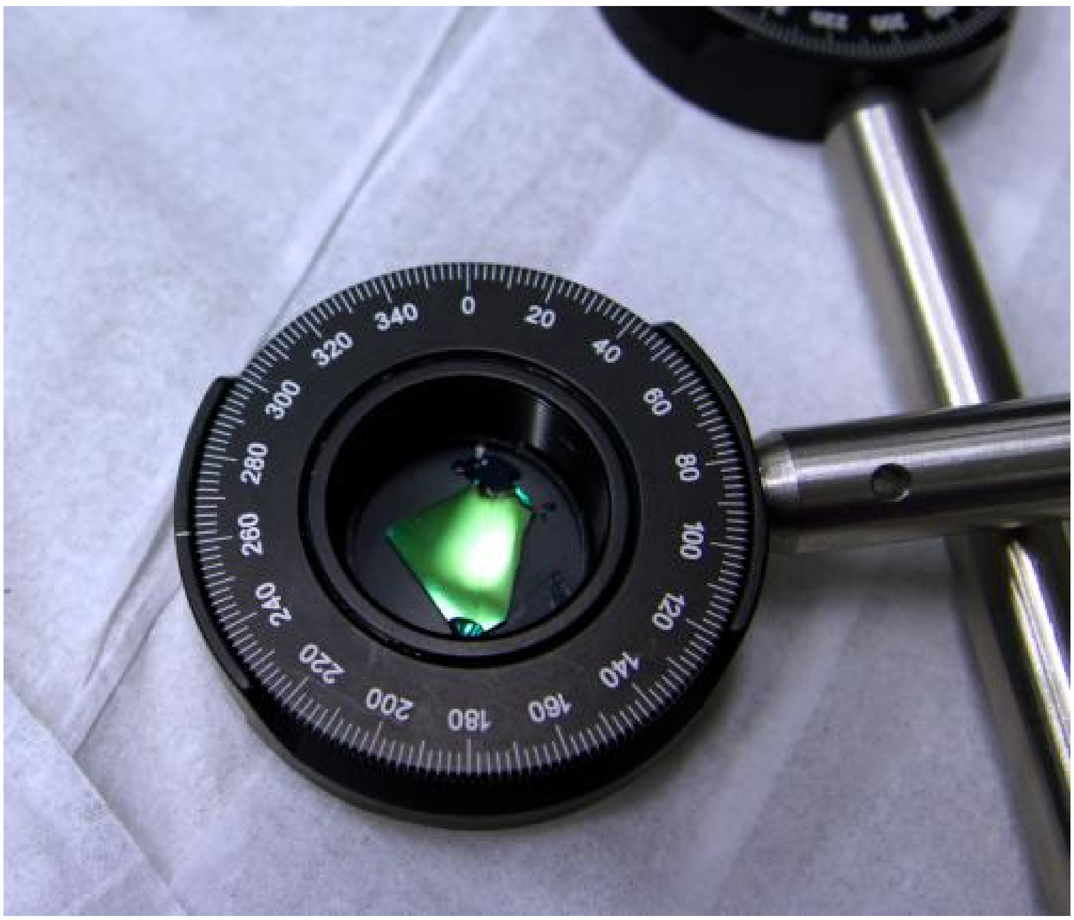

This thin green crystal, developed by a company in Switzerland, is used to convert near-infrared laser light into terahertz frequencies, which are useful for a range of experiments. (Photo by Glenn Roberts Jr.)

(Phys.org) -- In the first successful experiment of its type at SLAC's

Linac Coherent Light Source, scientists used terahertz frequencies of light to change the magnetic state of a sample and then measured those changes with ultrafast pulses from a powerful X-ray laser.

Invisible to human eyes, terahertz describes a band of frequencies between microwave and infrared light. These frequencies are alluring to scientists because they can be used to control and study magnetic and electric states in materials, and have been applied to fields ranging from data storage to biological imaging and explosives detection. They provide an atomic-scale window into fundamental processes such as magnetism, molecular motion and protein vibrations.

But observations in the terahertz range were until recently largely out of reach for scientists, said Matthias Hoffman, a SLAC scientist specializing in terahertz laser research who worked on the latest experiments. "There were no real efficient sources and detectors. It was relatively difficult to do science" at terahertz frequencies, he said.

The experiment in July involved a technique called pump-probe in which one laser, the "pump," is used to stimulate changes in the sample – in this case a material with exotic magnetic properties – while the X-ray laser probes these changes.

A team led by Urs Staub of the Paul Scherrer Institute in Switzerland and Steven Johnson of the Institute for Quantum Electronics at ETH Zurich in Switzerland generated the terahertz laser pulses by aiming an infrared laser beam at a specialized crystal. The passage through the crystal changed the frequency of light from near-infrared to terahertz light. The terahertz pulses then hit a sample, and the researchers measured changes in the sample using closely synchronized pulses from the LCLS X-ray laser.

The crystal they used was a special type of thin organic crystal known by the acronym DAST, grown by a private company in Switzerland. DAST crystals tend to be more fragile and susceptible to damage than some non-organic crystals designed for terahertz conversion, Hoffmann noted. He is working with the LCLS laser group to develop better sources of intense terahertz pulses as a regular option for LCLS users conducting pump-probe experiments.

Hoffman said another possible way to generate terahertz frequencies is with the electron beams that power advanced synchrotrons and LCLS. "This can produce even higher pulse energies," he said, but has proven more challenging for use in experiments.

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