White-light laser is basis of new optical tweezers and microscope

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Penn State engineers have used a "white-light laser" to produce a new type of optical "tweezers" that not only traps, holds and moves microscopic objects but also can perform characterization of the object via spectroscopy at the same time.

Dr. Zhiwen Liu, assistant professor of electrical engineering who leads the project, says, "Our team is among the first to demonstrate the 3-dimensional trapping and manipulation of microscopic objects using white laser light. Our novel tweezers, thanks to the broadband nature of white light, also have the potential to perform optical scattering spectroscopy of the trapped object over a broad wavelength range."

Through optical spectroscopy, researchers can probe the trapped particle's size, shape, refractive index and chemical composition. In experiments, so far, the team has demonstrated the tweezers's capabilities with three kinds of polymer microspheres of different sizes.

The new tweezers were described Friday, May 27, in a paper, “White Light Supercontinuuum Optical Tweezers,” presented at the Conference on Laser and Electro-Optics/Quatum Electronics and Laser Science in Baltimore Md. The authors are graduate students Peng Li and Kebin Shi as well as Liu. The tweezers were also described in the paper, “Manipulation and Spectroscopy of a Single Particle by Use of White-light Optical Tweezers,” published earlier this year in Optics Letters.

The Penn State researchers have also incorporated a white light laser into

a confocal microscope system to speed image production while retaining the image clarity and ability to observe the object in layers available in conventional instruments. Images that require a second or more to be produced with a conventional confocal microscope need only tens of milliseconds in the white-light instrument.

Liu notes that many biological processes occur in milliseconds or less and the new confocal microscope has the potential to film them as they happen. He expects both the new tweezers and microscope to have applications not only in the biological and medical sciences but also in the microcircuit chip industry.

Propagating short laser pulses of infrared light, for example, in a photonic crystal fiber broadens its spectrum dramatically and generates supercontiuum white light. The white light produced in this way can be focused to a tiny spot just like a normal laser.

The Penn State researcher notes, "The broad spectrum of supercontinuum white light increases its information capacity and offers new opportunities for next generation optical information systems. "

The microscope was described in the paper, “Chromatic Confocal Microscopy Using Supercontiuum Light,” published last year in Optics Express.

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Source: Penn State