Force of acoustical waves tapped for metamaterials

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A very simple bench-top technique that uses the force of acoustical waves to create a variety of 3D structures will benefit the rapidly expanding field of metamaterials and their myriad applications -- including "invisibility cloaks."

Metamaterials are artificial materials that are engineered to have properties not found in nature. Thesematerials usually gain their unusual properties—such as negative refraction that enables subwavelength focusing, negative bulk modulus, and band gaps—from structure rather than composition.

By creating an inexpensive bench-top technique, as described in the American Institute of Physics' journal *Review of Scientific Instruments*, Los Alamos National Lab (LANL) researchers are making these highly desirable metamaterials more accessible.

Their technique harnesses an acoustical wave force, which causes nano-sized particles to cluster in periodic patterns in a host fluid that is later solidified, explains Farid Mitri, a Director's Fellow, and member of the Sensors & Electrochemical Devices, Acoustics & Sensors Technology Team, at LANL.

"The periodicity of the pattern formed is tunable and almost any kind of particle material can be used, including: metal, insulator, semiconductor, piezoelectric, hollow or gas-filled sphere, nanotubes and nanowires," he elaborates.

The entire process of structure formation is very fast and takes anywhere from 10 seconds to 5 minutes. Mitri and colleagues believe this technique can be easily adapted for large-scale manufacturing and holds the potential to become a platform technology for the creation of a new class of materials with extensive flexibility in terms of periodicity (mm to nm) and the variety of materialsthat can be used.

"This new class of acoustically engineered materials can lead to the discovery of many emergent phenomena, understanding novel mechanisms for the control of material properties, and hybrid metamaterials," says Mitri.

Applications of the technology, to name only a few, include: invisibility cloaks to hide objects from radar and sonar detection, sub-wavelength focusing for production of high-resolution lenses for microscopes and medical ultrasound/optical imaging probes, miniature directional antennas, development of novel anisotropic semiconducting metamaterials for the construction of effective electromagnetic devices, biological scaffolding for tissue engineering, light guide, and a variety of sensors.

More information: The article, "Characterization of acoustically engineered polymer nanocomposite metamaterials using x-ray microcomputed tomography," by Farid G. Mitri, Fernando H. Garzon, and Dipen N. Sinha, appears in the journal *Review of Scientific Instruments*. See: link.aip.org/link/?RSI/82/034903

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