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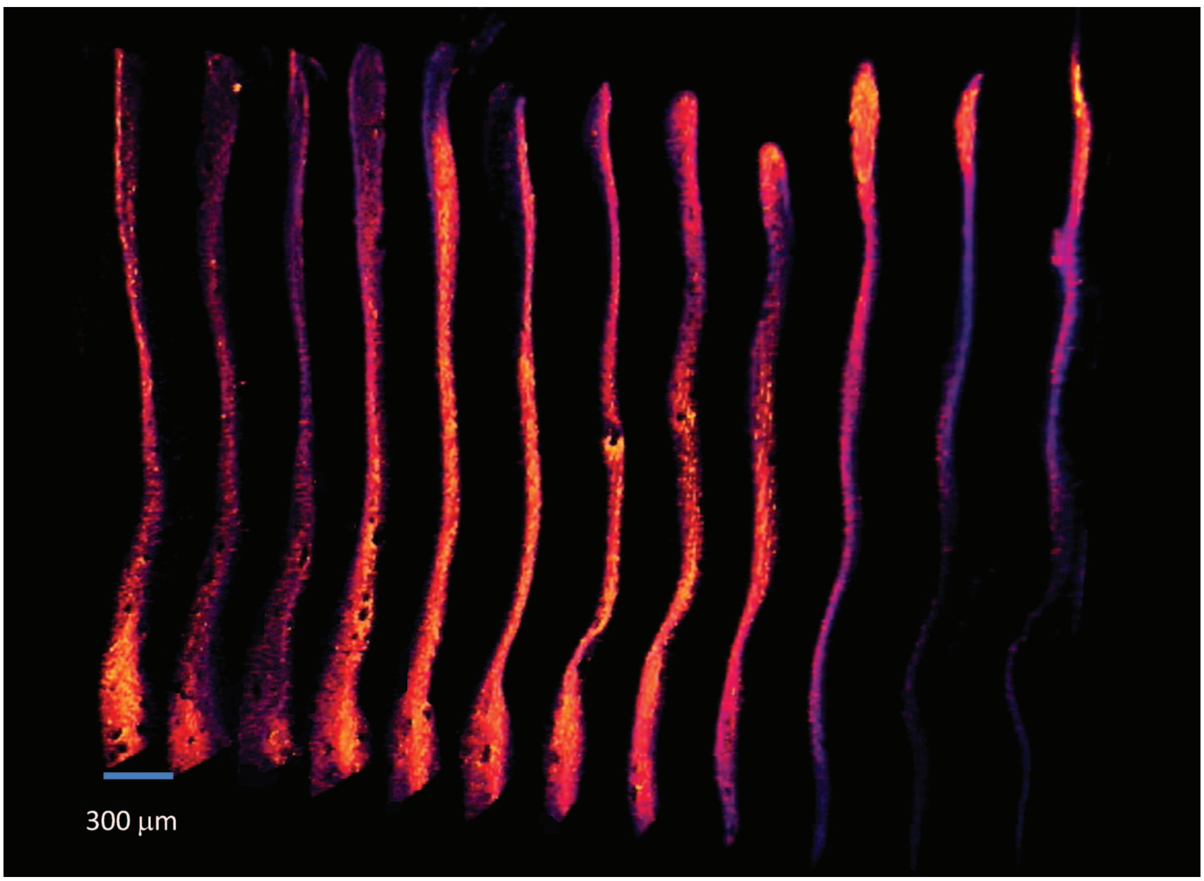

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Acoustic Assembly of Nanocomposite Metamaterials and Characterization Using X-Ray Micro-Computed Tomography

The cover shows an X-ray micro-computed tomography (XμCT) rendering of an acoustically engineered nanocomposite periodic metamaterial structure based on ~10-nm-diameter copper nanoparticles (). Epoxy principal and curing solutions were mixed in a $12 \times 12 \times 45$ mm plastic container (wall thickness 1 mm) and diluted with 1 mL of ethyl alcohol. About 10 mg of copper nanoparticles were poured into the plastic container and the mixture was then slowly hand-stirred for 1 min using a metallic micro-needle to produce a quasi-homogeneous blend solution. Two rectangular ultrasound transducers were connected to the rectangular plastic chamber on opposite sides and aligned to create a counter-propagating ultrasonic wavefield. The transducers were driven by an RF power amplifier coupled to two continuous wave signals obtained from two output channels of a function generator operating at 2.1 MHz.

The ultrasound field was activated for the duration of the epoxy curing cycle. During this time period, clusters of copper nanoparticles were trapped and patterned by the acoustic radiation force that directed them toward the nodes of the standing wave field to form quasi-parallel periodic planes. The spacing of the resulting planes of particle clusters is highly sensitive to the tuning frequency and the physical properties of the host medium (in this case, ethanol-diluted epoxy). After solidification, the transducers were removed and the plastic container was extracted before characterizing the internal morphological structure of the metamaterial with XμCT. With XμCT, it was possible to verify the quality of the pattern's periodicity and to image the internal metamaterial structure in addition to other micro-structural features.

Images courtesy of Farid G. Mitri, Los Alamos National Laboratory, Materials Physics and Applications Division, Los Alamos, NM. For further reading, see the accompanying article, F. G. Mitri, F. H. Garzon, and D. N. Sinha, "Characterization of acoustically engineered polymer nanocomposite metamaterials using x-ray microcomputed tomography," *Rev. Sci. Instrum.*, vol. 82, no. 3, art. no. 034903, 2011.