MITMECHE

Colloquium

Mechanical Engineering Lecture in Design

Enabling Engineered Properties via Architectured Materials

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Architectured materials (a.k.a. mechanical metamaterials) achieve properties that derive primarily from their microstructure instead of their composition. Preliminary experimental and simulated results obtained from sub-millimeter-sized samples of such materials show promise for achieving currently unobtainable combinations of super properties that would enable a host of next-generation technologies, but two major barriers are preventing their practical implementation. (i) Design tools are currently limited in their ability to sufficiently enable the topological synthesis and optimization of architectured materials because their complex features span multiple orders of magnitude and sometimes don't repeat with manageable periodicity. (ii) Fabrication approaches do not currently exist that can fabricate practical volumes of such materials while also achieving their architecture's submicron-sized features. Fabricating such features in a repeatable way using multiple constituent materials is also a challenge.

Professor Hopkins' Flexible Research Group has focused much of their efforts at UCLA toward overcoming these challenges. This seminar will provide an overview of the design and fabrication tools that they have generated in the context of practical architectured-material applications. These design tools leverage the simplified mathematics of the Freedom and Constraint Topologies (FACT) synthesis approach to rapidly search the full design space of both periodic and aperiodic architectured topologies to achieve desired combinations of properties. The group's fabrication tools utilize custom-developed components (e.g., a flexure-based micro-mirror array) to generate multiple optical traps that are independently controlled to assemble large numbers of different material micro-particles simultaneously for rapidly constructing desired microstructures.