Department of Engineering Physics
UNIVERSITY OF WISCONSIN–MADISON

A Master's Thesis Defense

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Tunable Dynamic Properties of Vertically Aligned Carbon Nanotube Foams

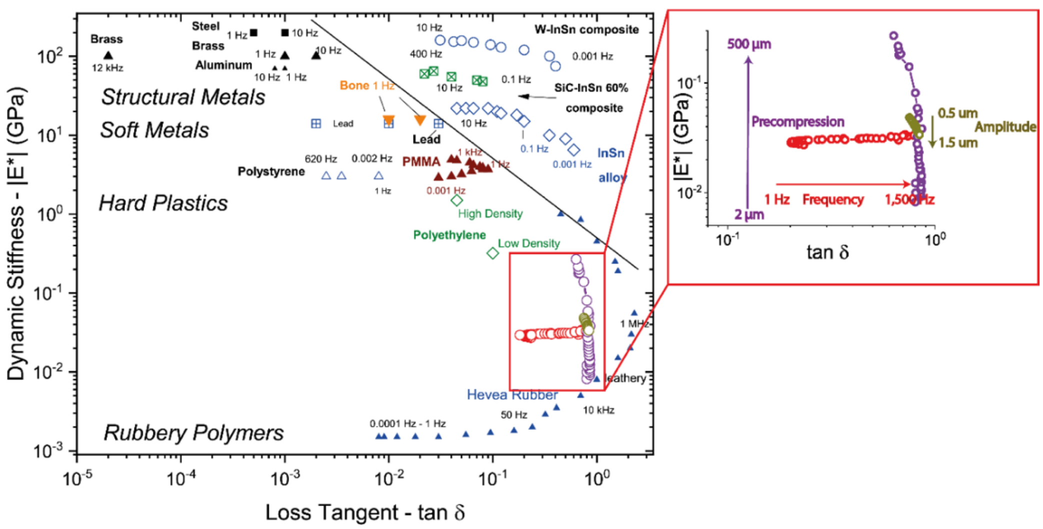

Fig.1: The Tunable Dynamic Properties of VACNT Foams.

The damping and the stiffness are often mutually exclusive mechanical properties that exhibit interdependent scaling in materials. Controlling mechanical waves in extreme environment require synergistically enhanced damping and stiffness in lightweight materials that are also independently tunable. We demonstrate independently controllable superior damping and stiffness in vertically aligned carbon nanotube (VACNT) foams by exploiting their synthesis-tailored structural hierarchy and structural gradients (Fig.1). Because of the multiscale structural interactions, the VACNT foams exhibit high dynamic stiffness and damping over three-orders-of-magnitude excitation frequencies (1 Hz to 1.5 kHz). They also exhibit a strain-softening behavior with increasing excitation amplitude while the damping remains nearly constant. The dynamic stiffness is dramatically tunable while maintaining near-constant damping by applying a variable static precompression that exploits the intrinsic structural gradients. Developing independent control over the critical dynamic properties via engineered hierarchical materials with structural gradients will potentially enable the creation of non-Hermitian mechanical metamaterials as well as enable active control of extreme mechanical waves and vibrations.

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