Passive Damping using Magnetostrictive Composites

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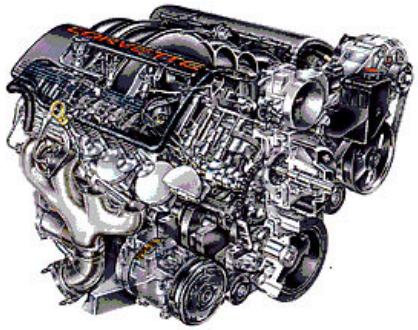
Applications

Spacecraft

Aircraft

Temperature
Energy absorption
Structural properties



Automotive

Sports Equipment

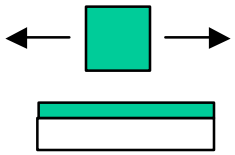
Damping Technologies

Passive

Visco-Elastic Materials

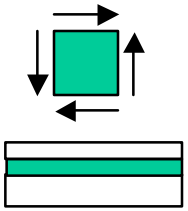
Free Layer Damping

extensional strain



Constrain Layer Damping

shear strain



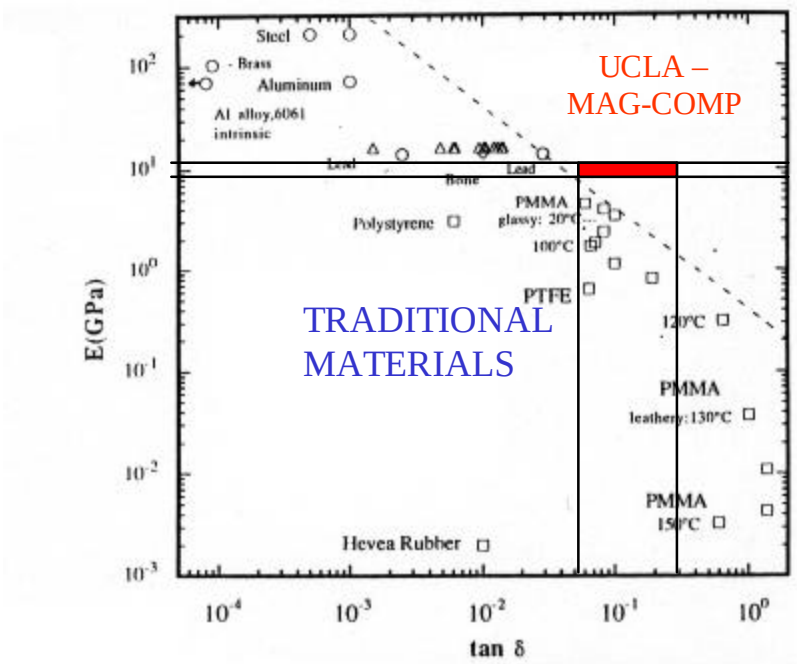
Active

Broad-band Performance

Complexity / Integration

Cost

Stiffness Loss Map



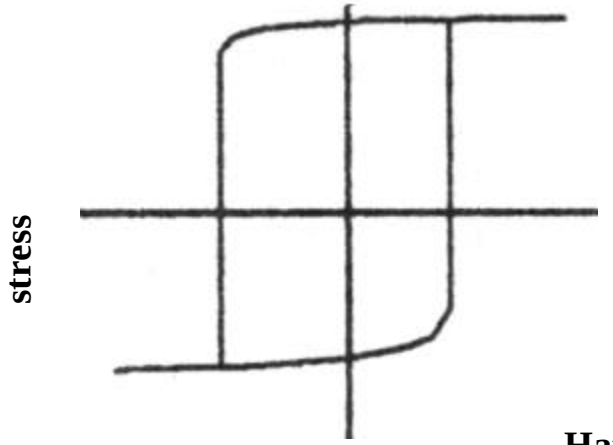
Brodt & Lakes, `95

Magnetostrictive Composite Properties

- **High stiffness (3 - 25 GPa)**
- **Tunable stiffness**
- **Large working temperature range**
- **Stress amplitude dependence**

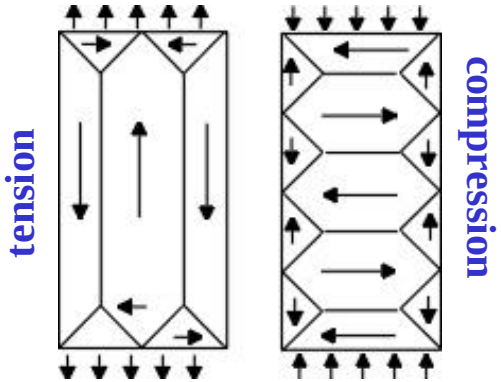
- **Structural integration**
- **Complex geometries**
- **Comp/Shear/Tension loading**

THEORETICAL BOUND
80% ENERGY ABSORPTION



Hathaway and Clark

DAMPING MECHANISM
STRESS-DOMAIN INTERACTION



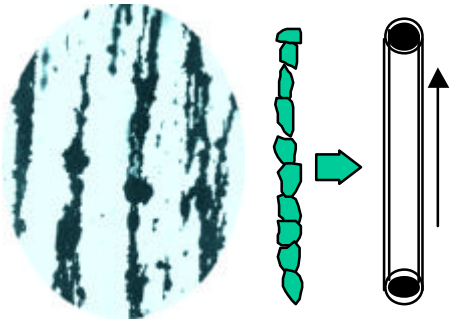
Particulate Composite Manufacturing

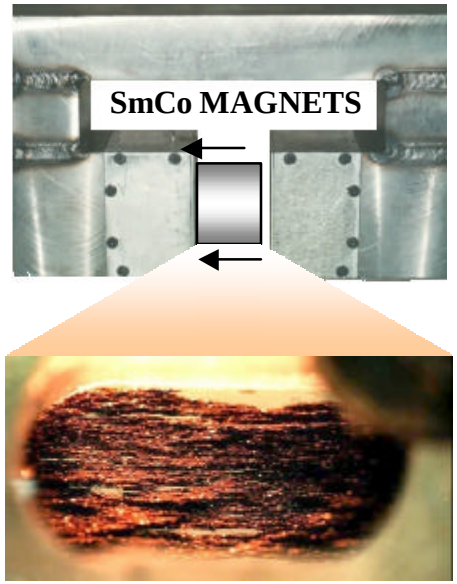
TERFENOL-D PARTICULATE

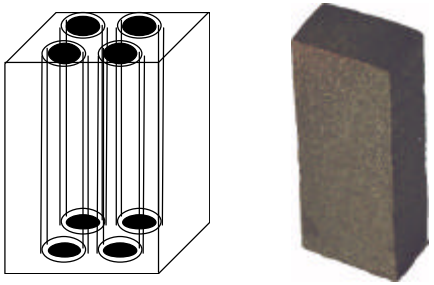
MIXING + DEGASSING

POLYMER RESIN

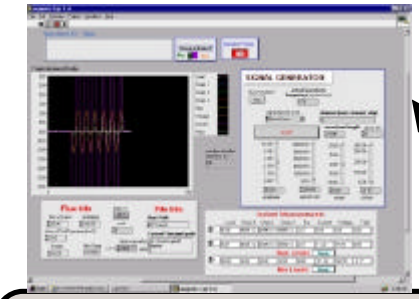
PARTICLE ALIGNMENT AND SUSPENSION







Combined Magneto-Mechanical Characterization



Computer Control
and Acquisition
(LAbView)

MECHANICAL

Hydraulic Axial-Torsion

- load control
- multi-axial loading

High Cycle Hydraulic Axial

- 0 - 1000 Hz

4 Channel Strain Conditioning

Thermal (-60 ℃ to 150 ℃)

MAGNETIC

Water Cooled Solenoid

- 0 to 6 kOe
- computer input signal

Integrating Fluxmeter

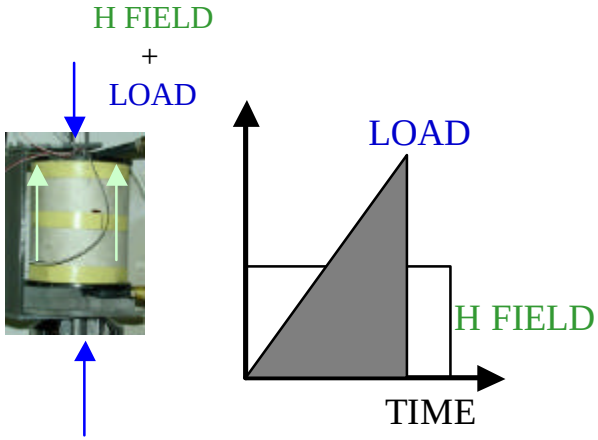
Miniature Hall-Effect Probe System

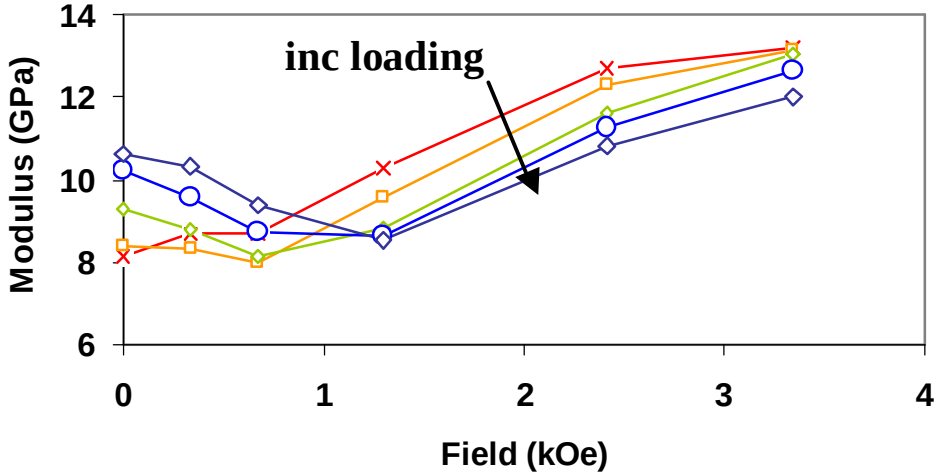
Lock-In Amplifier

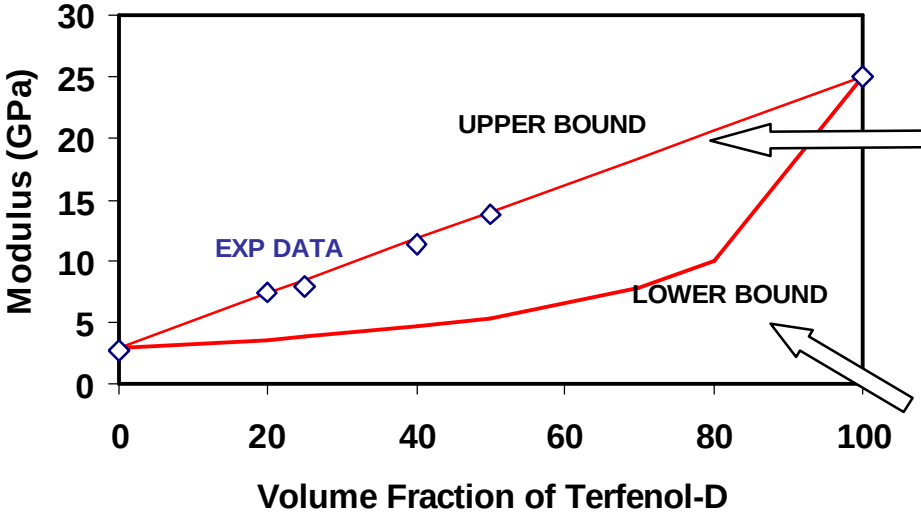
Specimen

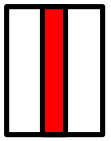
Active Materials Lab
http://amlseas.ucla.edu

Stiffness Properties



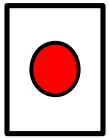






UPPER BOUND

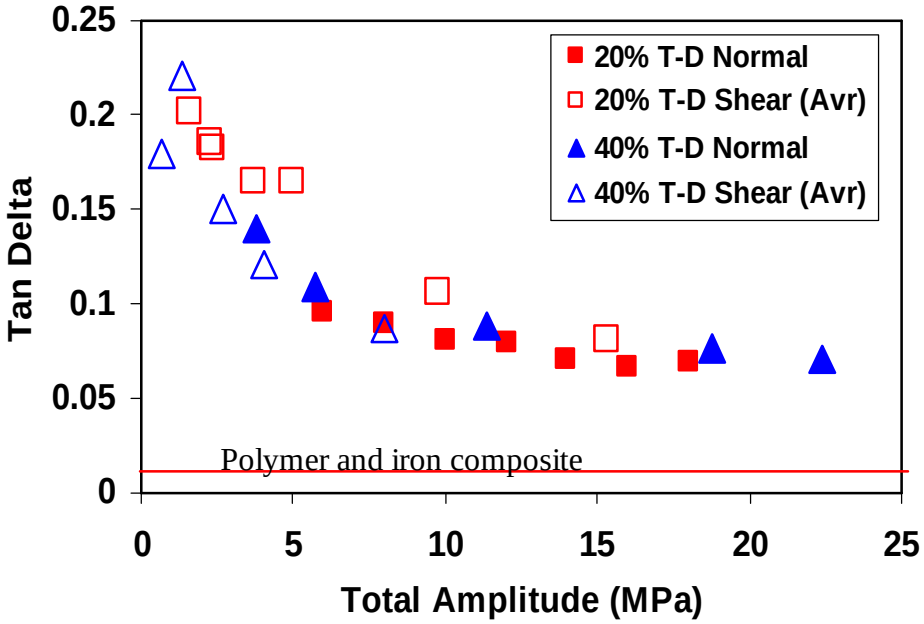
Composite Models

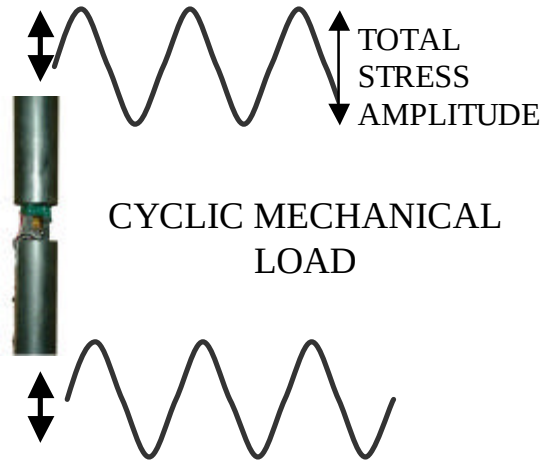


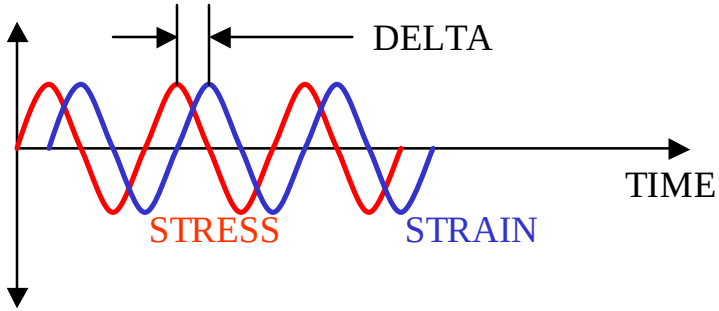
LOWER BOUND

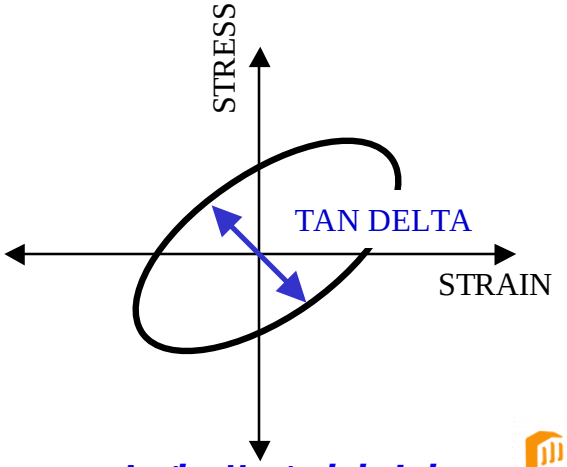
Active Materials Lab
http://amlseas.ucla.edu

Tan Delta – Stress Dependence

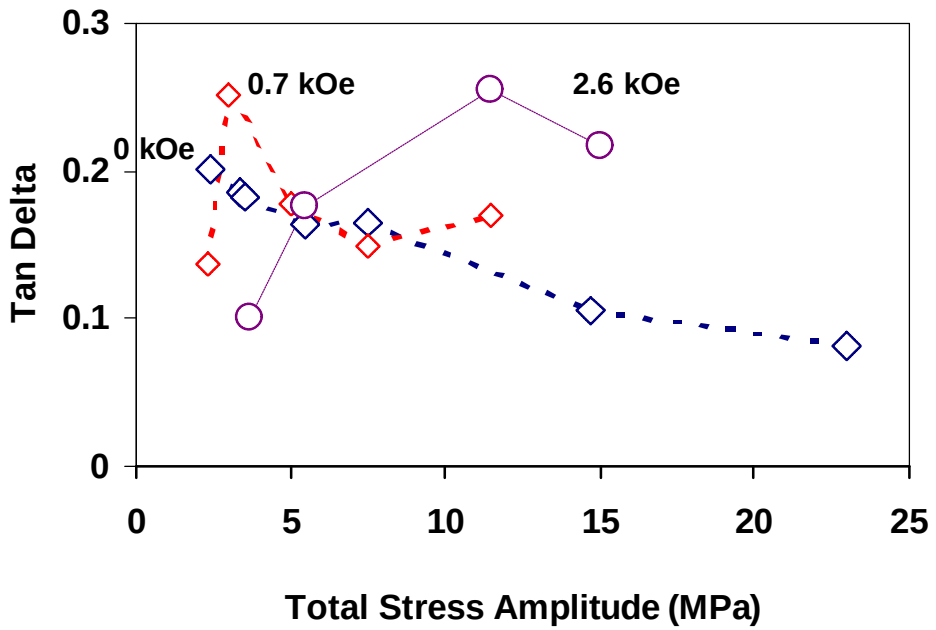


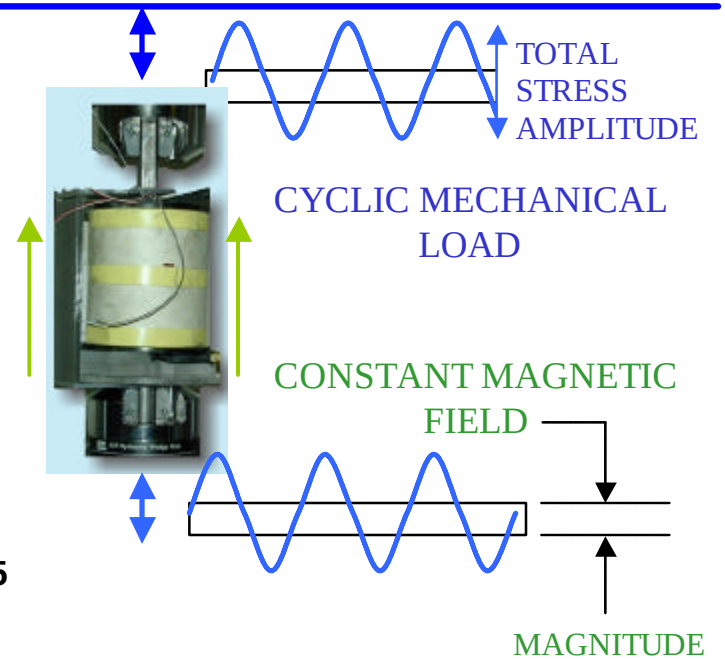




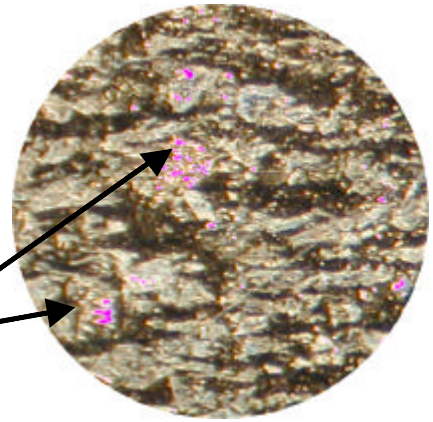


Tan Delta – Field Dependence





- **Stress amplitude is a function of magnetic field**



HYBRID
PARTICLES

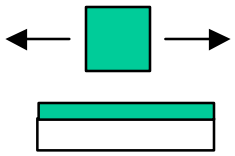
Damping Technologies

Passive

Visco-Elastic Materials

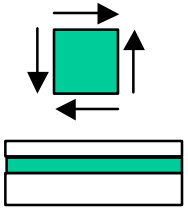
Free Layer Damping

extensional strain



Constrain Layer Damping

shear strain



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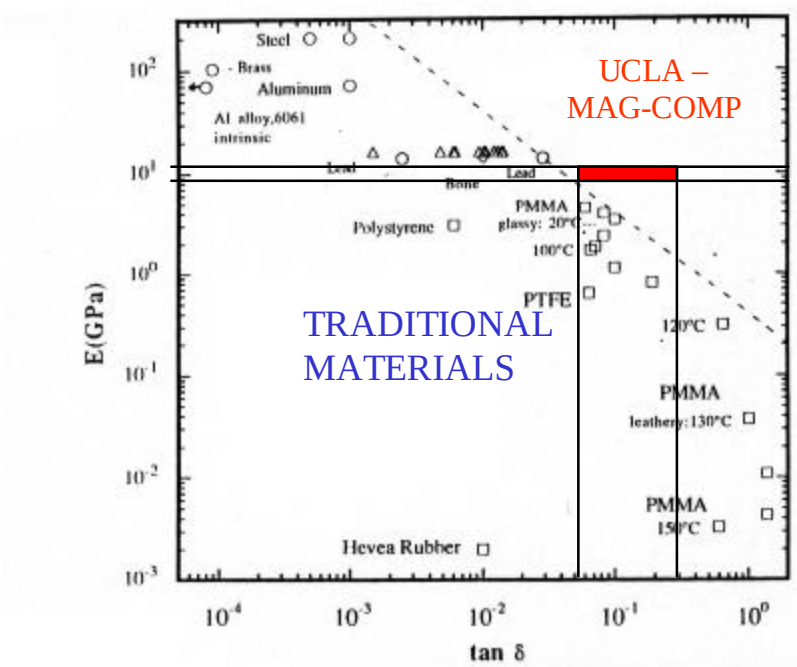
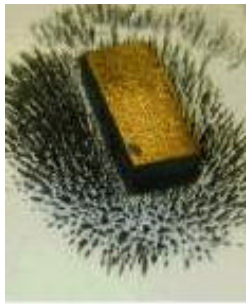


Brodt & Lakes, `95

Conclusions

Major Accomplishments

- **High stiffness - tunable**
- **25% energy absorption**
- **H Field – Hybrid evaluation**



Future Research

- **Structural Integration**
- **Single Domain Particles**
- **Exchange Coupled Systems**