Research Project: Rail Car

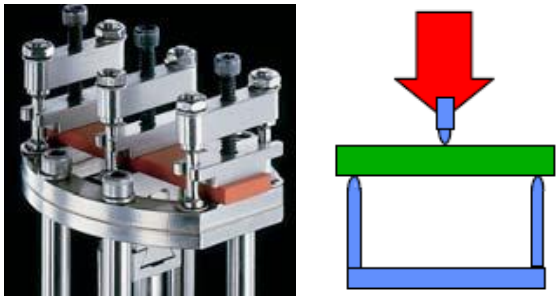
Research Topic: Dynamic Mechanical Analysis (DMA)

Problem

DMA is particularly useful for evaluating polymeric materials, which exhibit time, frequency, and temperature effects on mechanical properties because of their viscous nature.

Approach

DMA is a powerful technique which allows for the storage and loss modulus, damping and glass transition properties of viscoelastic materials to be characterized in the frequency domain by subjecting small samples to an oscillatory load under a controlled temperature program. At the onset of glass transition, the increase in molecular motion within these materials results in a dramatic step decrease in the storage modulus with a simultaneous increase in the damping (loss factor) values. Peaks of the tan delta or loss modulus curves are found to be sensitive indicators of glass transition temperature and are associated with the impact properties of elastomeric materials. The time-temperature superposition principle is also employed for characterizing the long-term behavior of polymeric material systems. A TA Instruments Model Q800 DMA was bought and being used at the University of Mississippi.

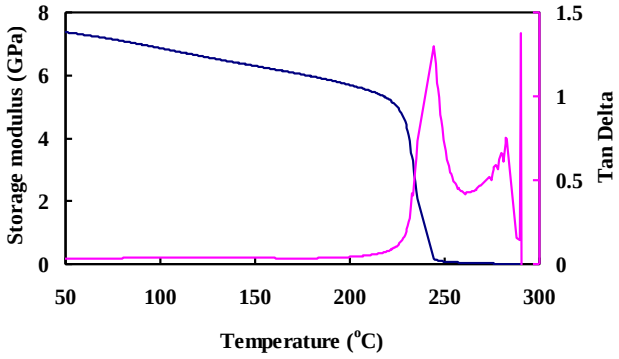


Single/ Dual Cantilever

Film tension

Findings

This instrument is being used for characterizing the viscoelastic response along with the long term creep and stress relaxation behavior of various thermoplastic and thermoset resins reinforced with carbon nano tubes, nanoclay and graphite platelets. For the Rail Car project, it is being used to measure the thermomechanical properties such as storage modulus and glass transition temperature. Materials of study are rubber, rubber-based composite and graphene paper. Figure below is an example showing the evolution of storage modulus with temperature for graphene-PEI paper from Michigan State University. The peak of Tan δ curve indicates glass transition temperature (T_g) of 245 ^oC.



Film tension, heating 10 ^oC/min, 1 Hz, in air.

Impact

The DMA results will be used to compare composite and its base polymer. The results will help to investigate the impact of nano fillers applied in composite. Particularly, the properties of materials from DMA will be storage modulus, T_g, and the width of T_g peak. Experimental results using DMA will also be used to obtain parameters that are needed for theoretical modeling. Final outcome will be a material data base that can be used for structural protection against various loading conditions.

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