



Dynamic Mechanical Properties of Magnetic Tape

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Dynamic Mechanical Analysis of Magnetic Tape

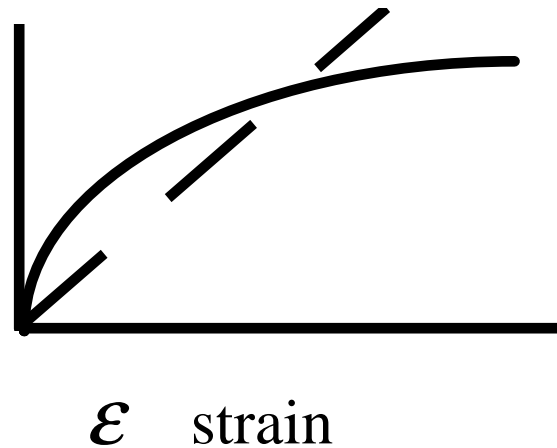


- Why is DMA important to Magnetic Tape
 - Viscoelastic polymers:
major component primarily responsible for tape handling characteristics.
- Topics of discussion
 - Solids Rheology (Elastic and Viscous)
 - Tape analysis (X and Y directions)
 - Surface Dynamics (Z direction)

Rheology Review

■ Stress-Strain Curve

σ
stress
or load



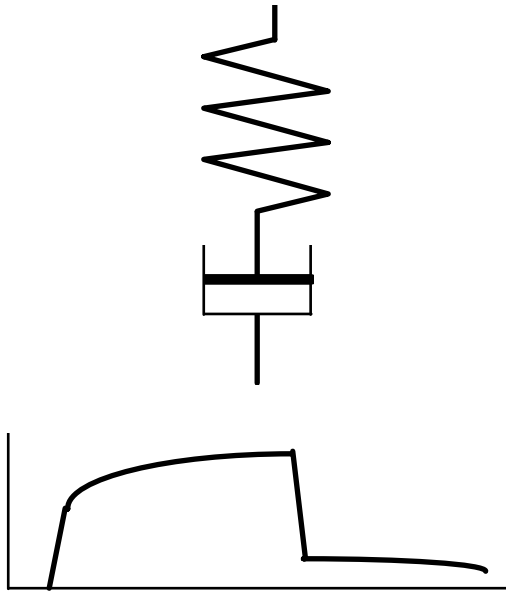
— — — Ideal
— Actual

■ Elasticity: Hooke's Law

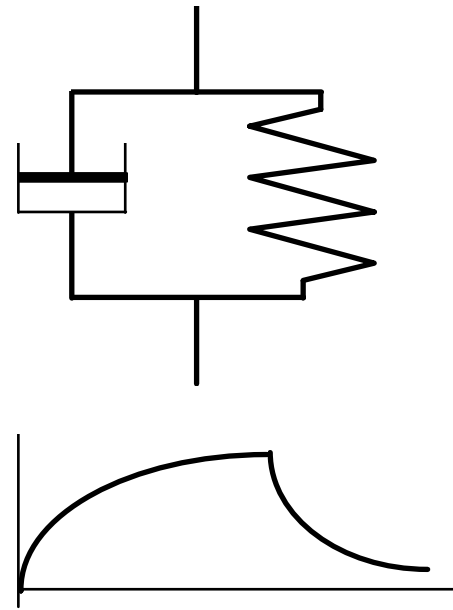
$$E = d\sigma/d\varepsilon = \text{Youngs Modulus}$$

Maxwell & Voight Model

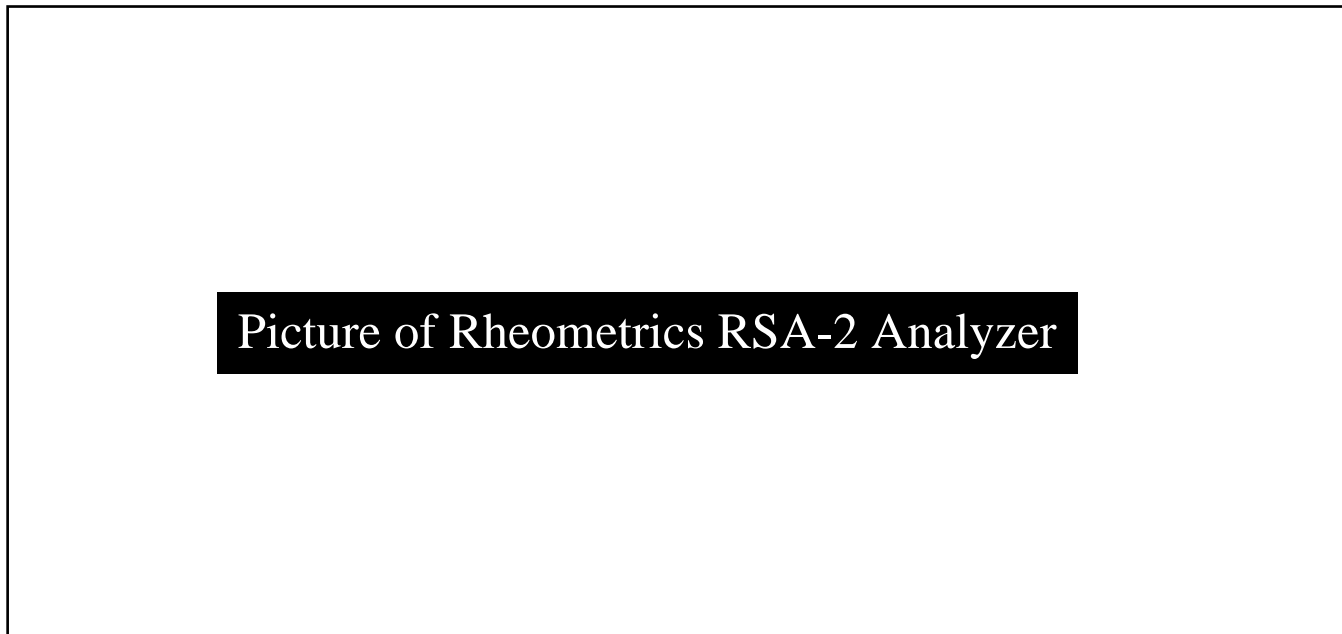
■ The Maxwell model of elastic and viscous responses was a good start.



The Voight model is better if creep is involved in the test.

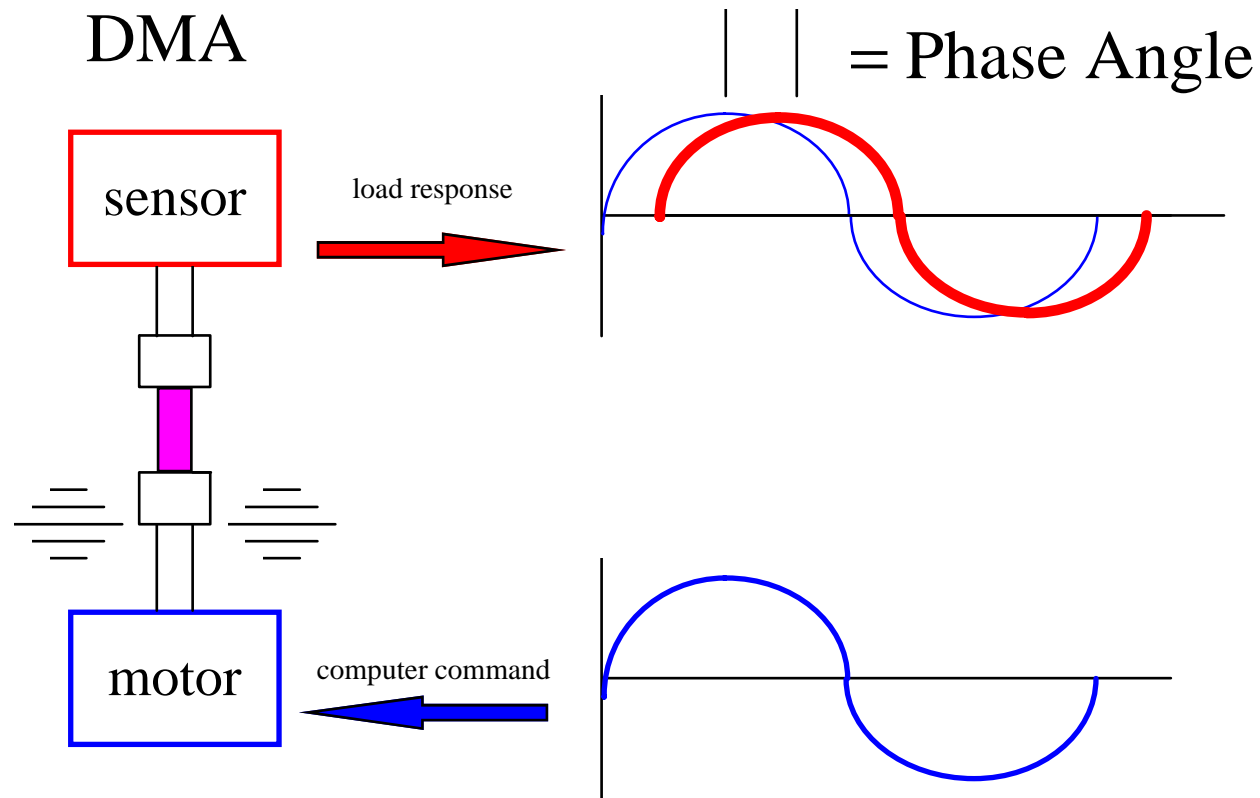


Rheometrics RSA 2 Solids Analyzer

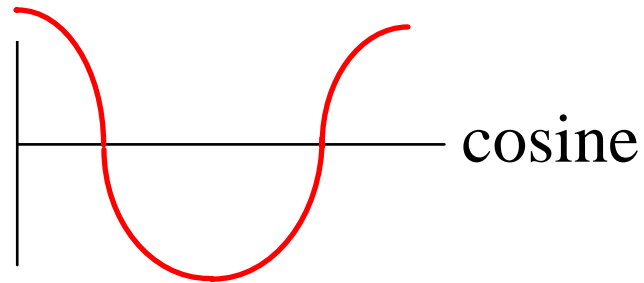


Picture of Rheometrics RSA-2 Analyzer

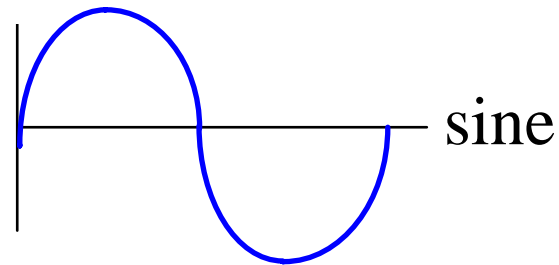
Dynamic Mechanical Testing



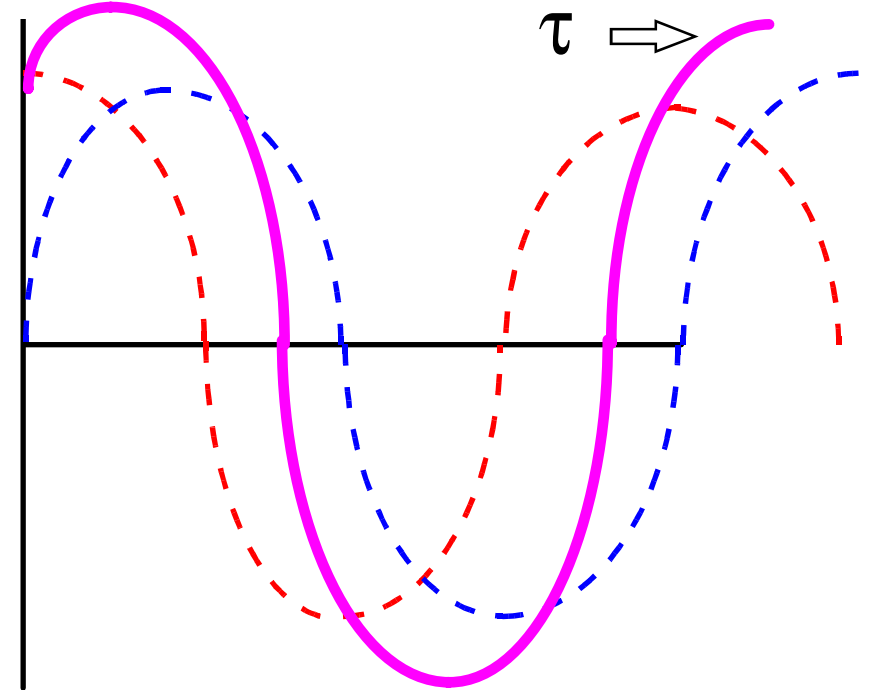
Dynamic Mechanical Analysis



Strain Rate
Viscous

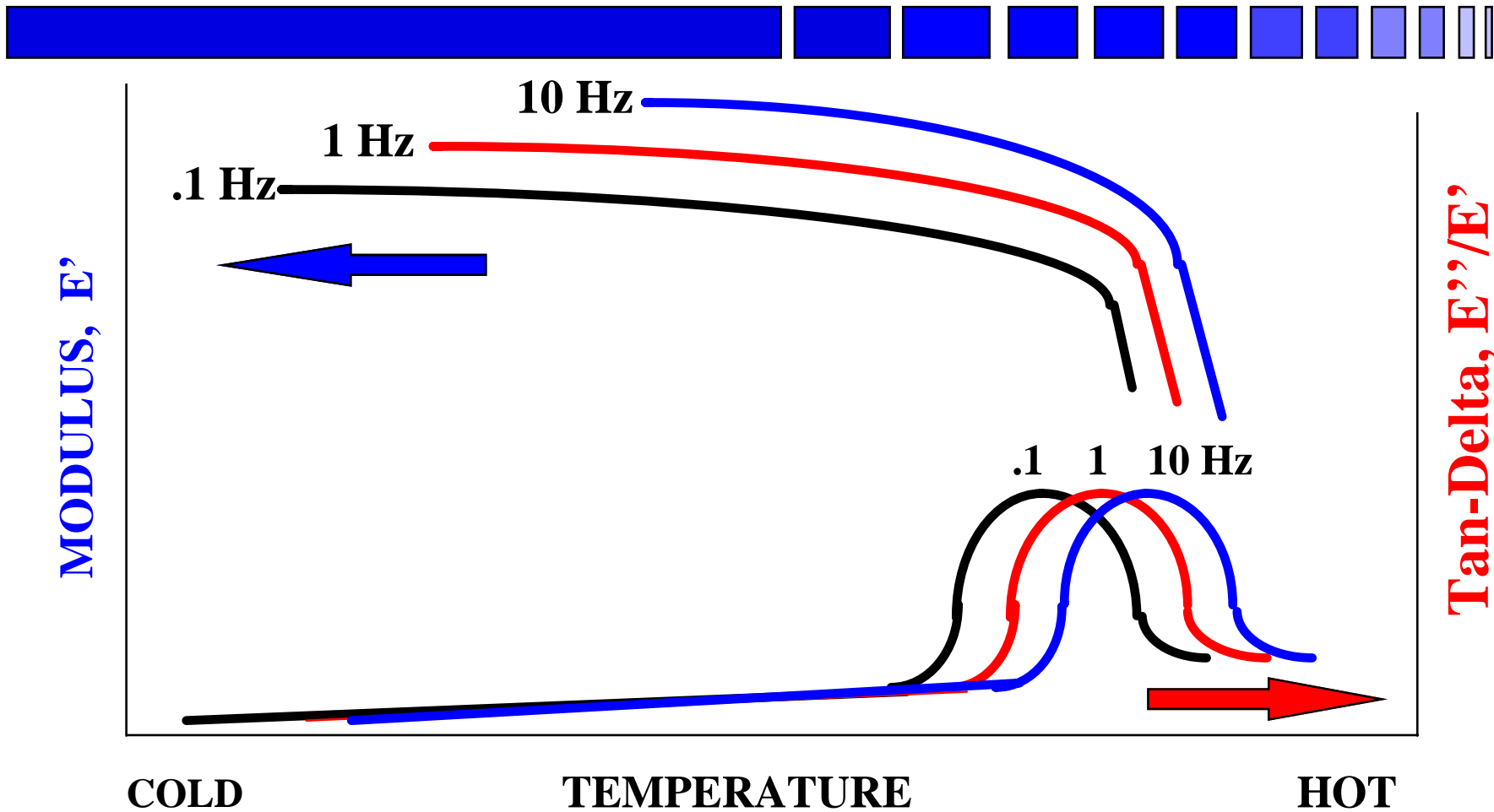


Strain
Elastic



Elastic + Viscous
 $(\sin\theta + \cos\theta) = \tau$

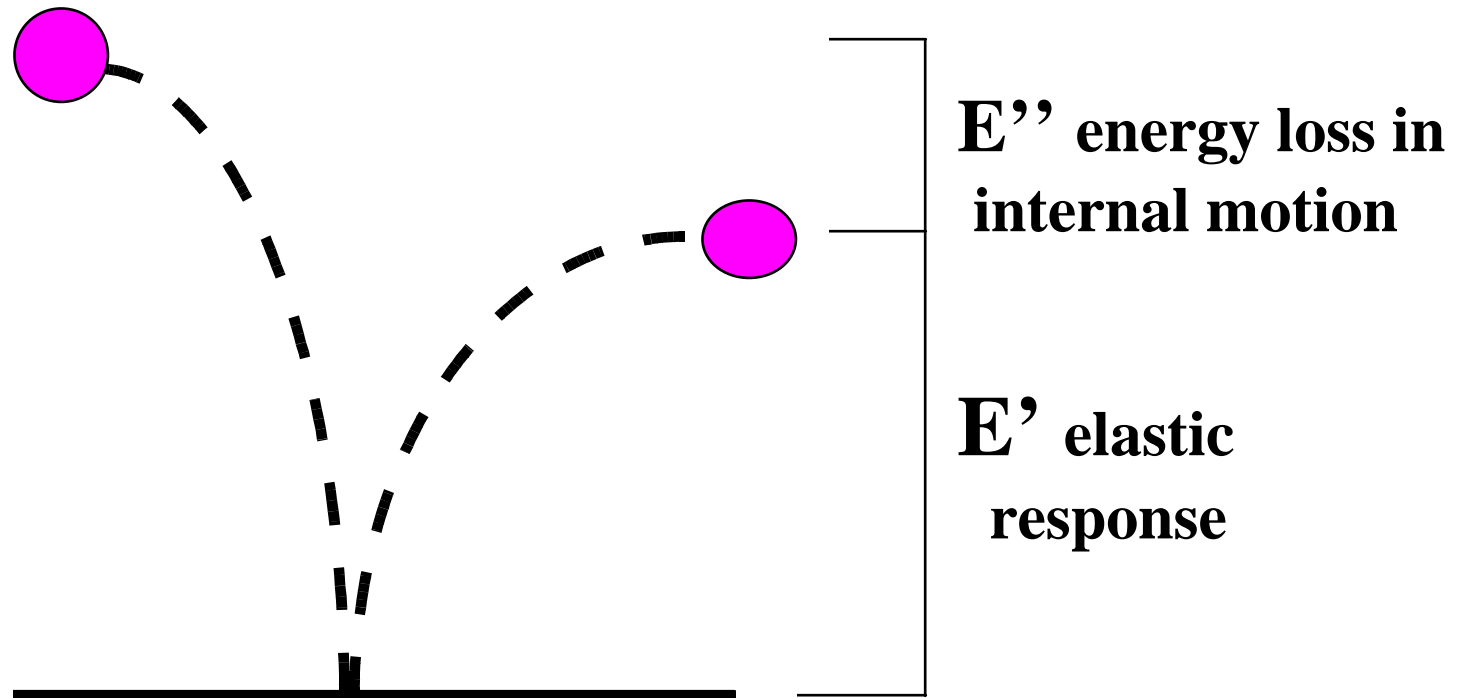
Typical DMA Analysis



Elastic Modulus & Loss Modulus



■ Bouncing a ball



Frequency Analysis of Tape



Frequency Analysis of Tape/Recorder

- Input trace of 1X to 3X rev
- 3D and 2D graph

Surface Dynamics



The Z direction

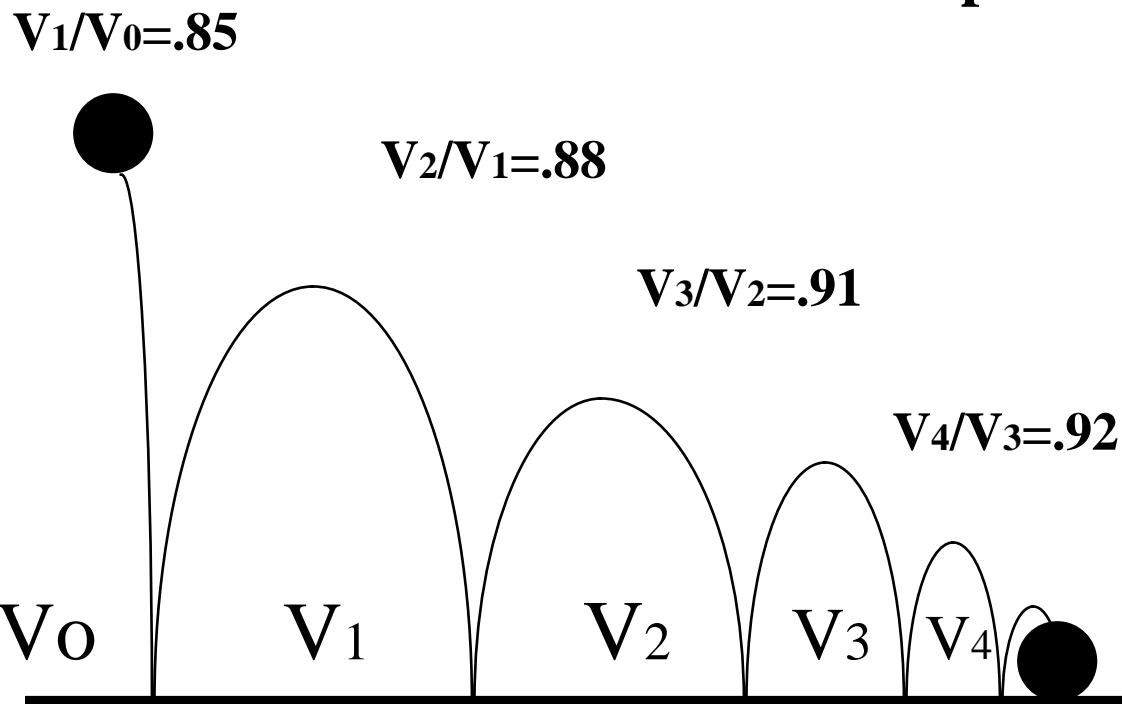
All mechanical forces imposed on tape must traverse the coated surfaces.

Various properties of both surfaces cause some loss at the interface, usually in the form of friction or thermal energy.

MEASURING SURFACE HARDNESS



$$\text{Coefficient of Restitution} = \frac{\text{rebound velocity}}{\text{impact velocity}}$$



To Review



DMA characterizes the viscoelastic properties of coatings and film using frequency and temperature dependent tests. Proper selection of the test parameters requires some prior knowledge of the dominant frequencies and temperatures that exist within the recorder.

Machine-direction data should be supplemented with transverse and z-direction tests in order to more accurately predict tape performance.

Acknowledgments



- Perkin-Elmer Corporation
- Rheometrics, Inc...
- Edmund Scientific