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Developing Dewetting Fingerprints for HTPB Propellants and Explosives

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Background

- Many energetics systems utilize HTPB based propellants or explosives.
- Dewetting (void, porosity formation) behavior of these propellants and explosives can drastically affect:
  - Sensitivity and IM response
  - Ballistic Performance
  - Mechanical Properties
- Current method for determining dewetting behavior (dilatometer testing) is time consuming and expensive.

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Approach

- Determine the True stress and strain using duel video extensometer.
- Capture dewetting events using acoustic emission sensor technology.
- Obtain Poisson's Ratio and Acoustic Dewetting Spectra.
- Produce dewetting fingerprint.

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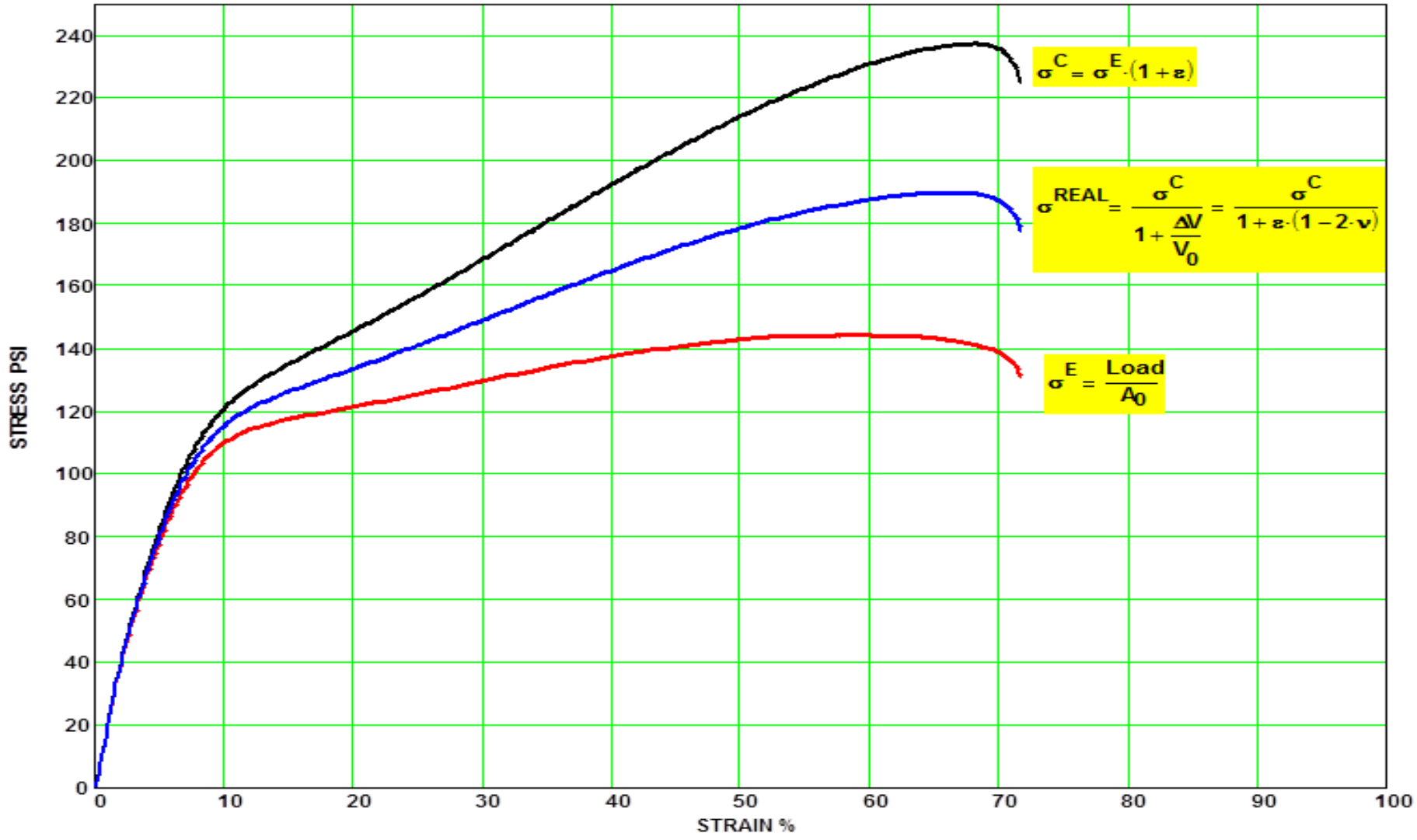
Knowing Poisson's ratio key to obtaining True (real) stress



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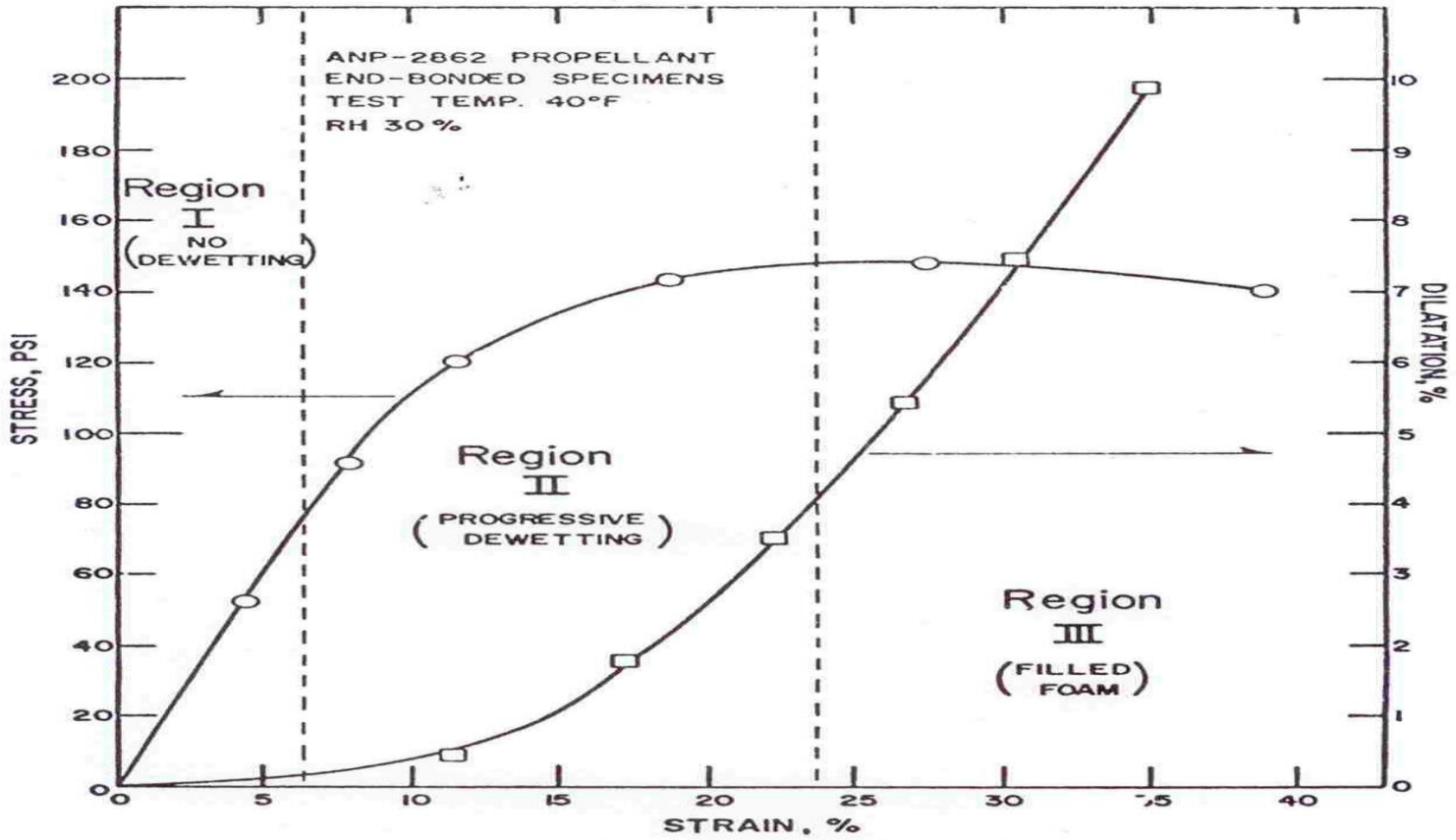
Textbook Standard Dewetting Model



COMPARISON OF UNIAXIAL STRESS-STRAIN AND DILATATION-STRAIN BEHAVIOR

FIGURE 3.0-3.

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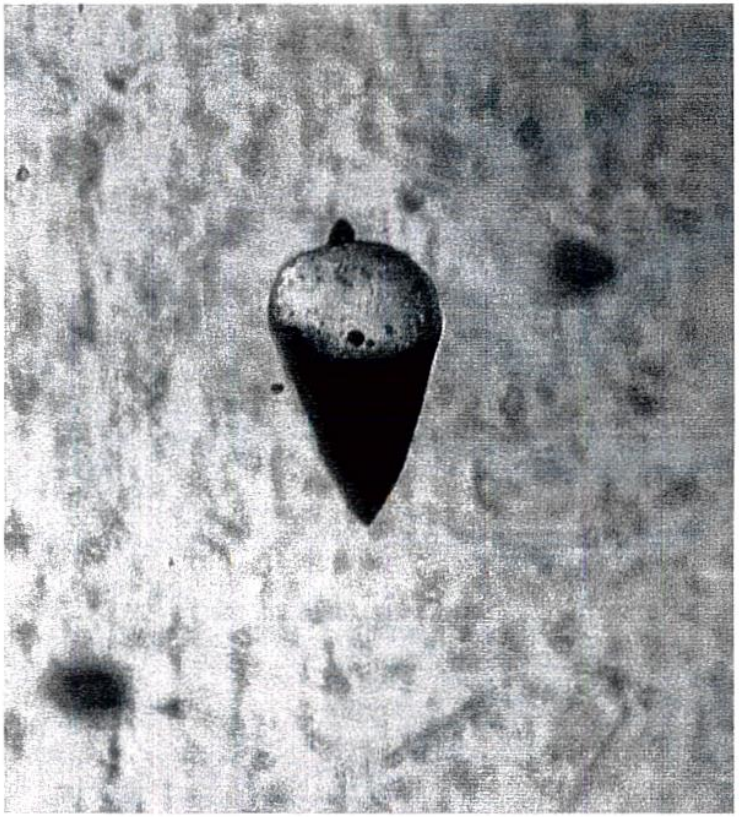
Dewetting: Standard Model

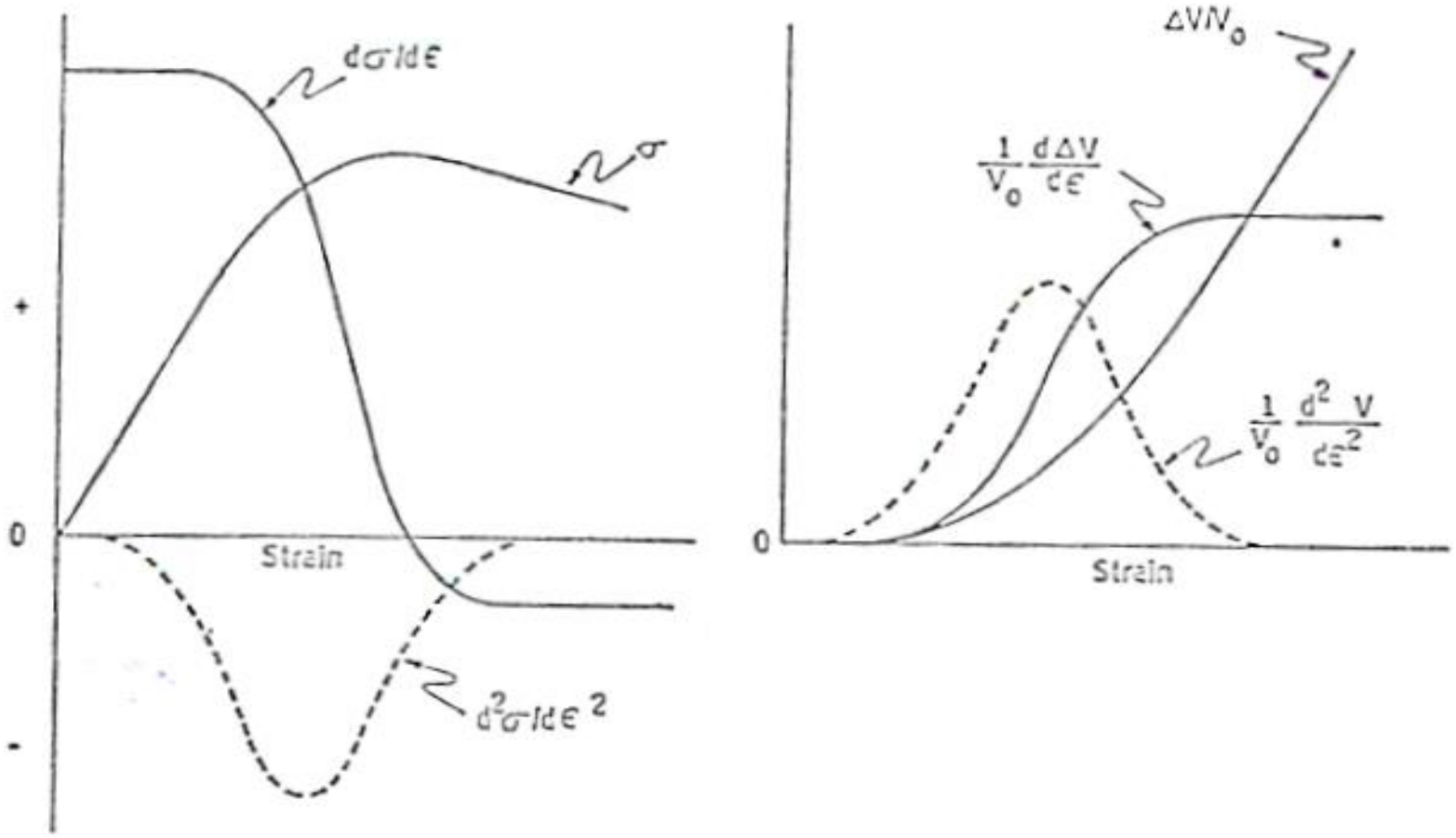
- Particle Dewetting: Void Formation



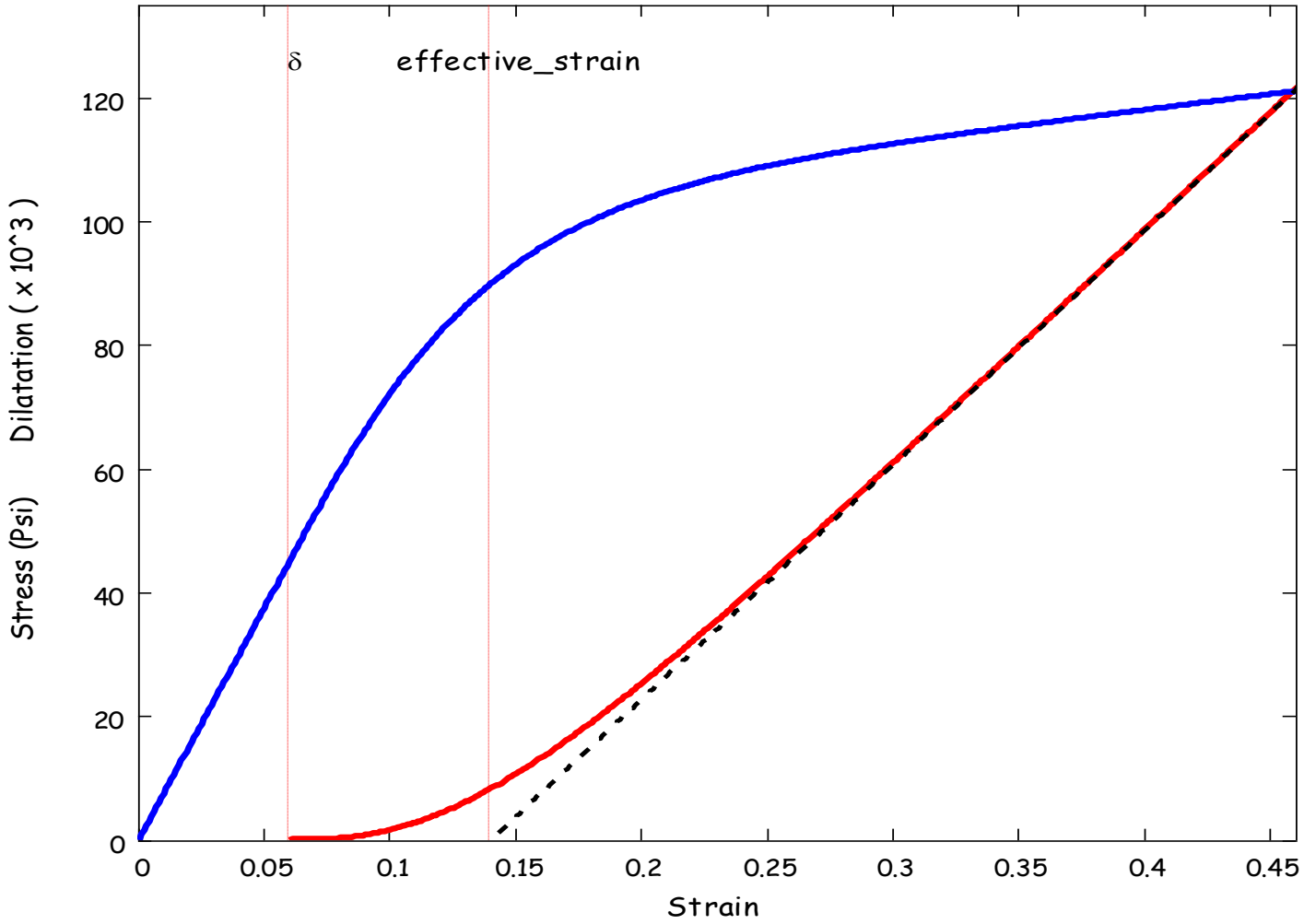
AP in HTPB/Tepanol before and after dewetting

Dewetting Standard Model (Farris 1968)

Dilatation Curve Equivalent to Stress-Strain Curve



Effective or Critical Strain: Key parameter from dilatation-strain curve



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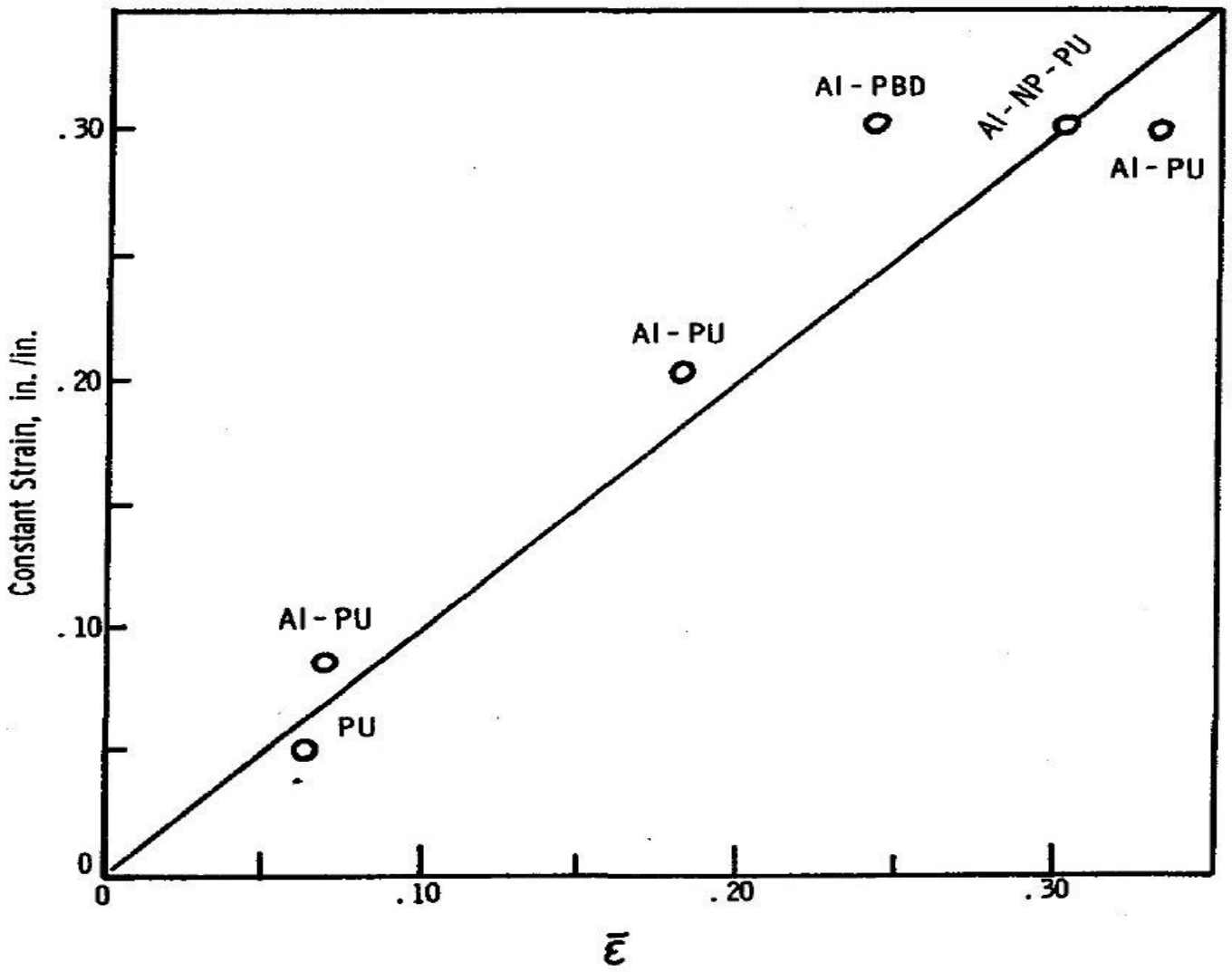
Endurance Strain = Effective Strain



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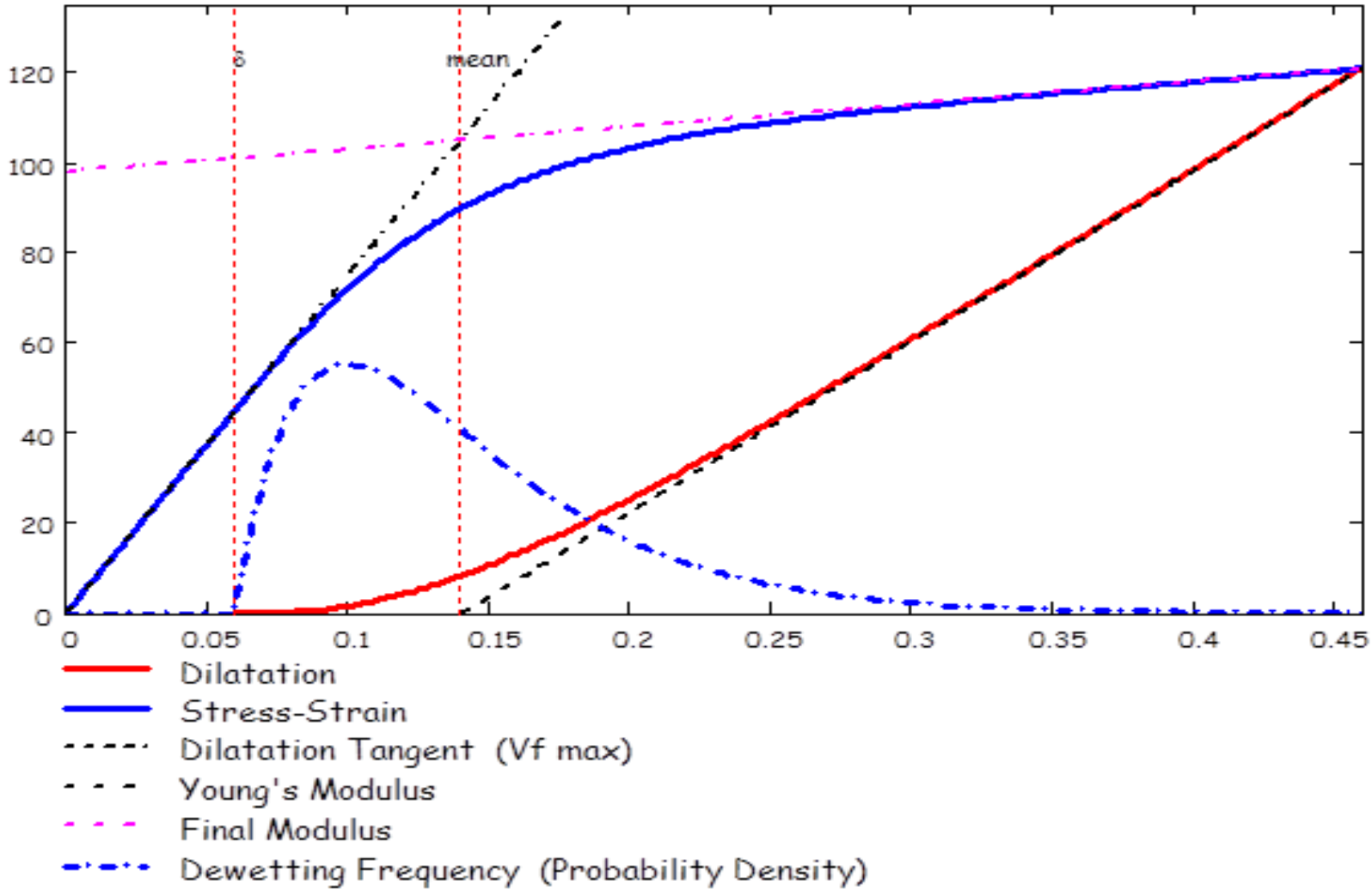
Dewetting Fingerprints

Effective Strain = Mean Strain (Rast. et. al. 1995)



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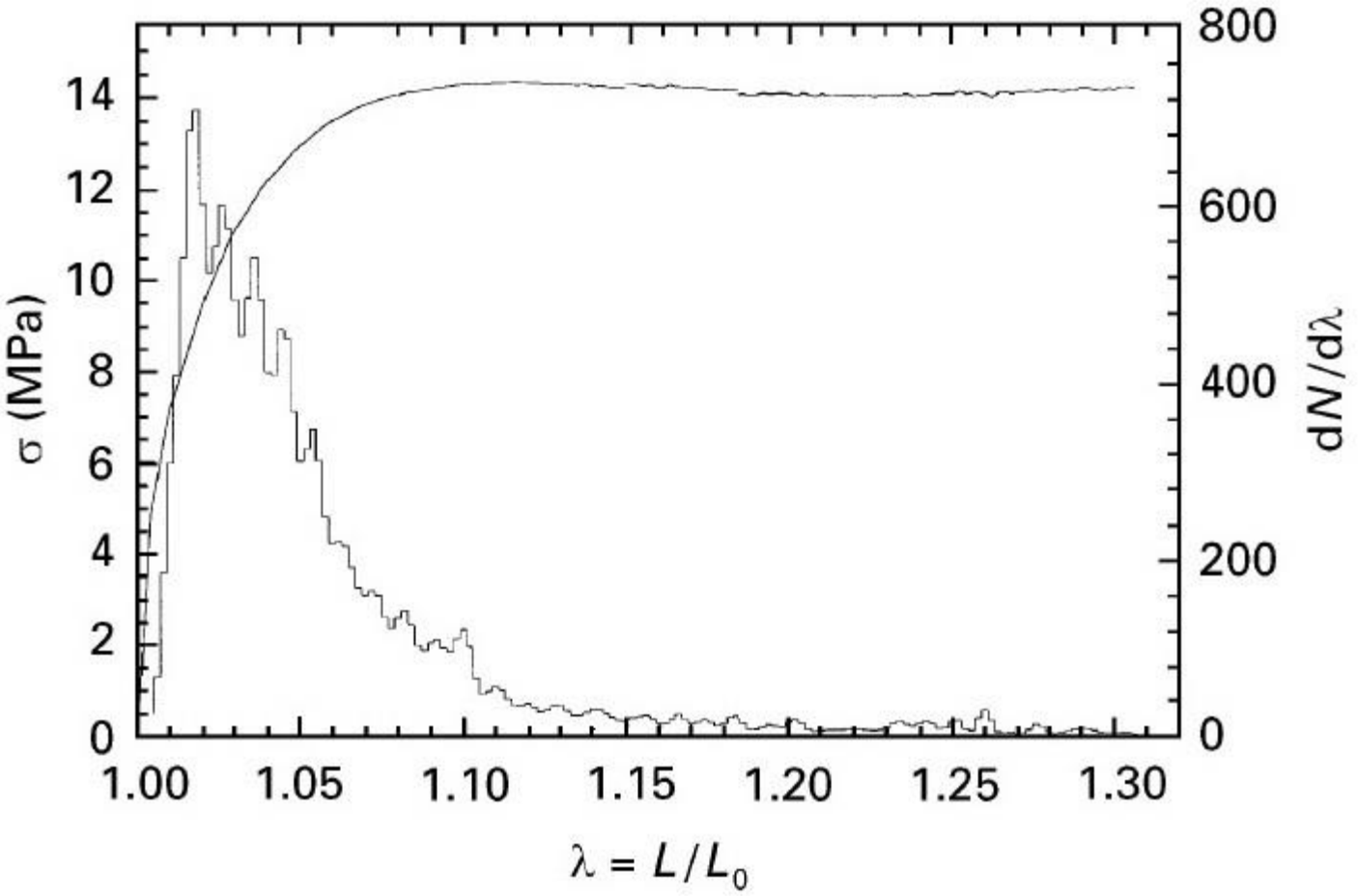
Acoustic Emission Dewetting Spectrum

Particle dewetting frequency via AE particle count.



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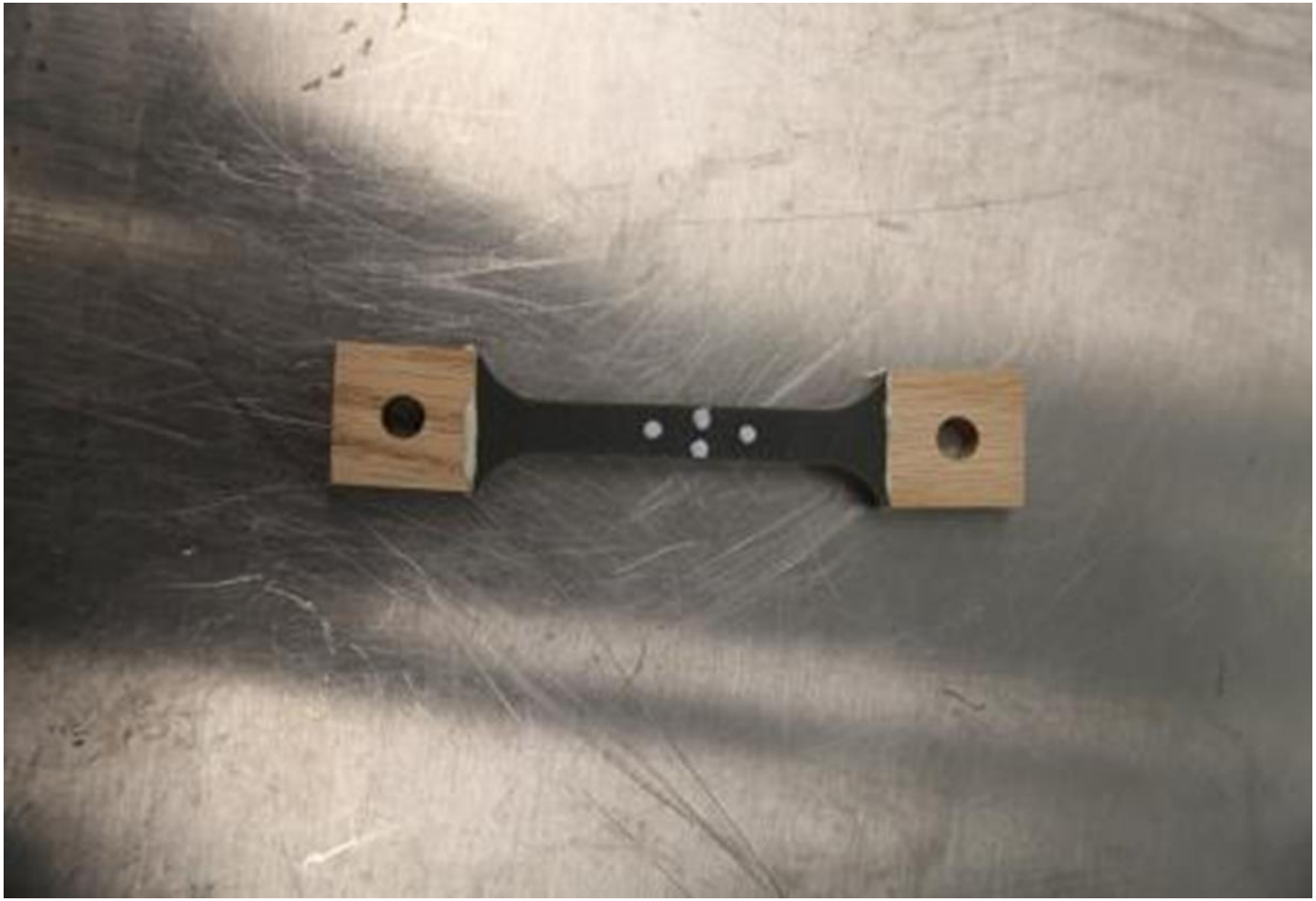
Results

Video dog bone setup



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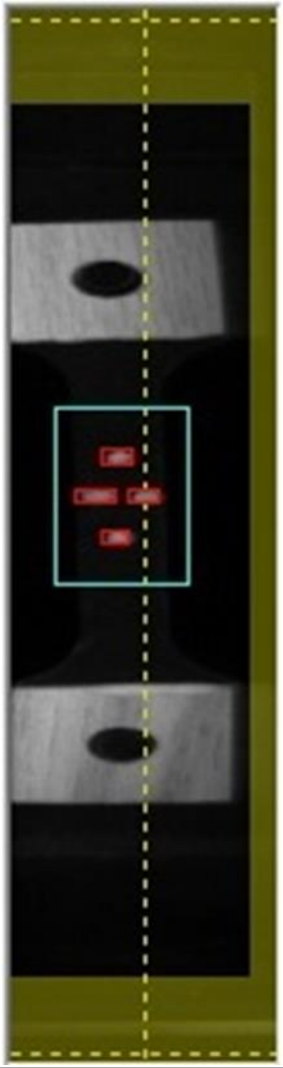
Results

Dual video testing



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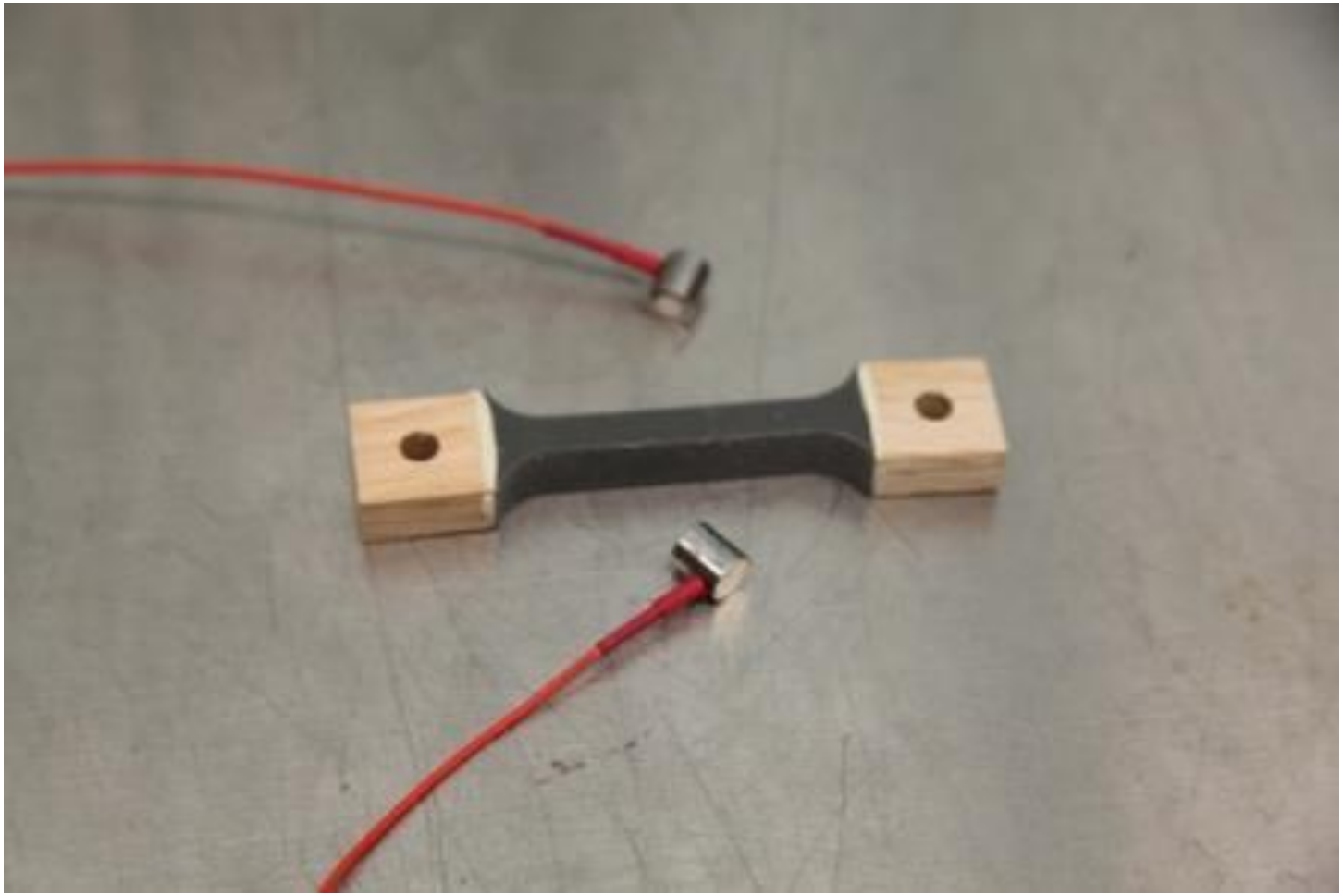
Results

Acoustic Emission sample setup



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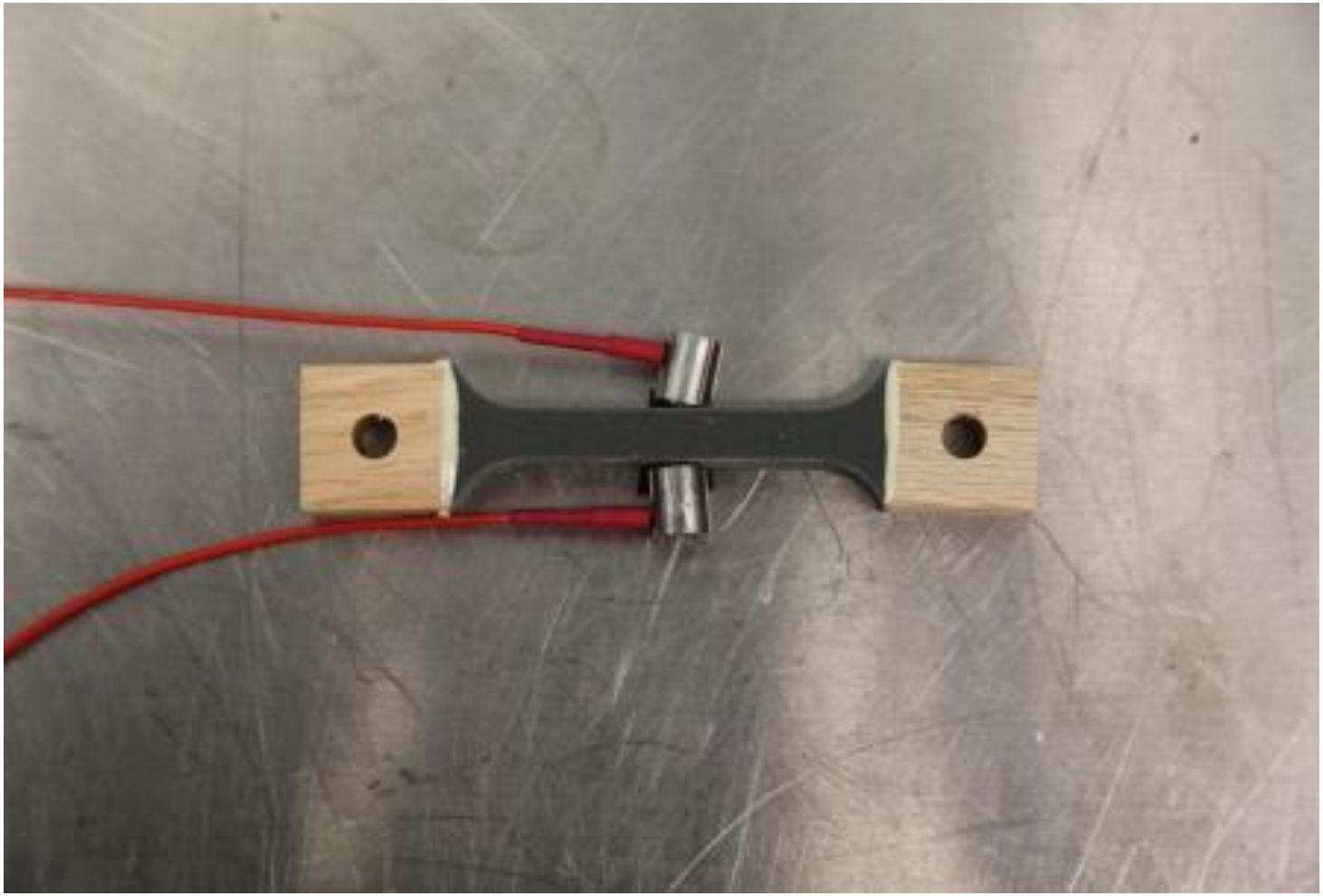
Results

Acoustic Emission sample setup



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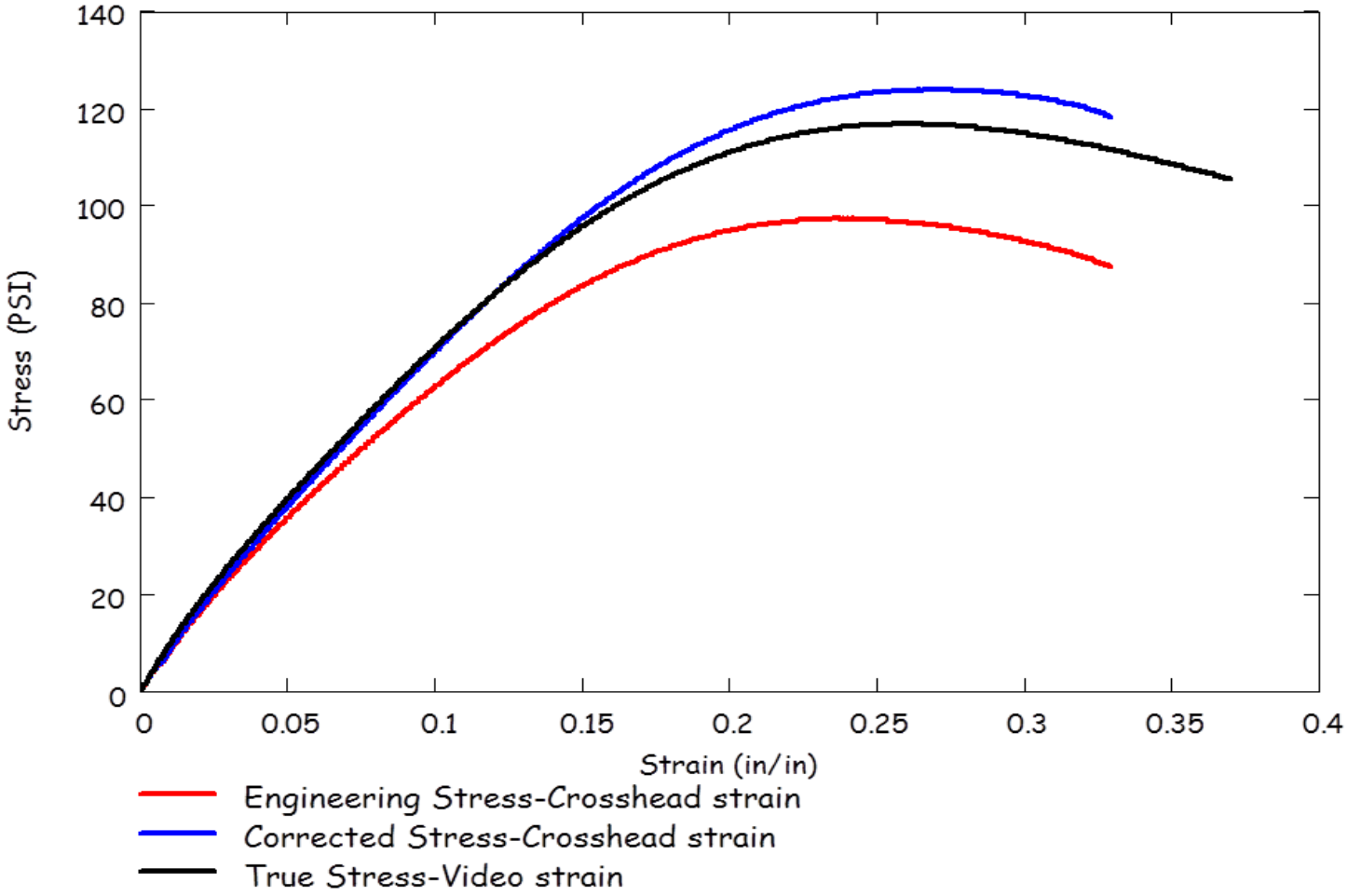
Results

Propellant “A” (HTPB/AP) Stress vs Strain



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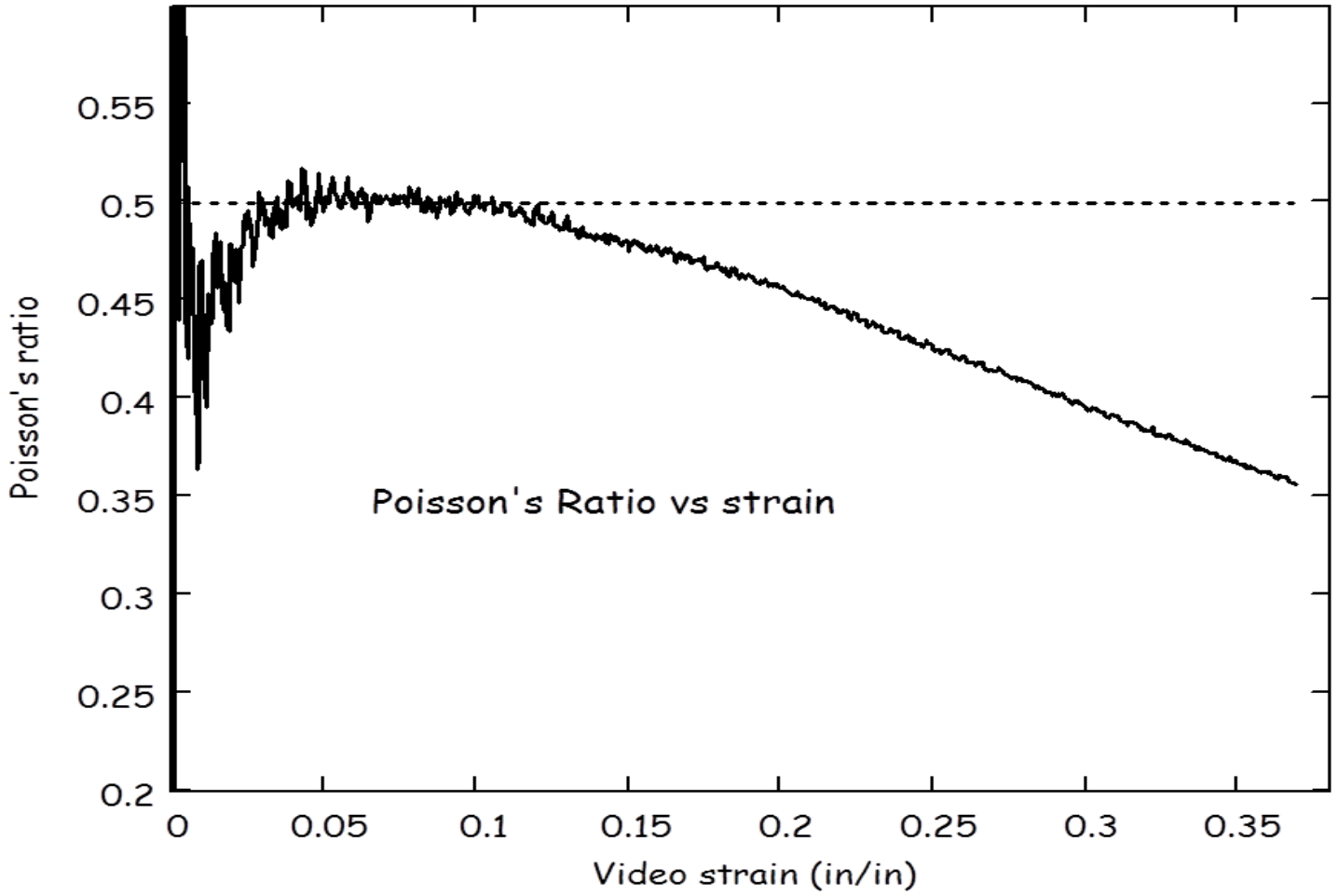
Results

Propellant “A” (HTPB/AP) Poisson’s Ratio vs. strain



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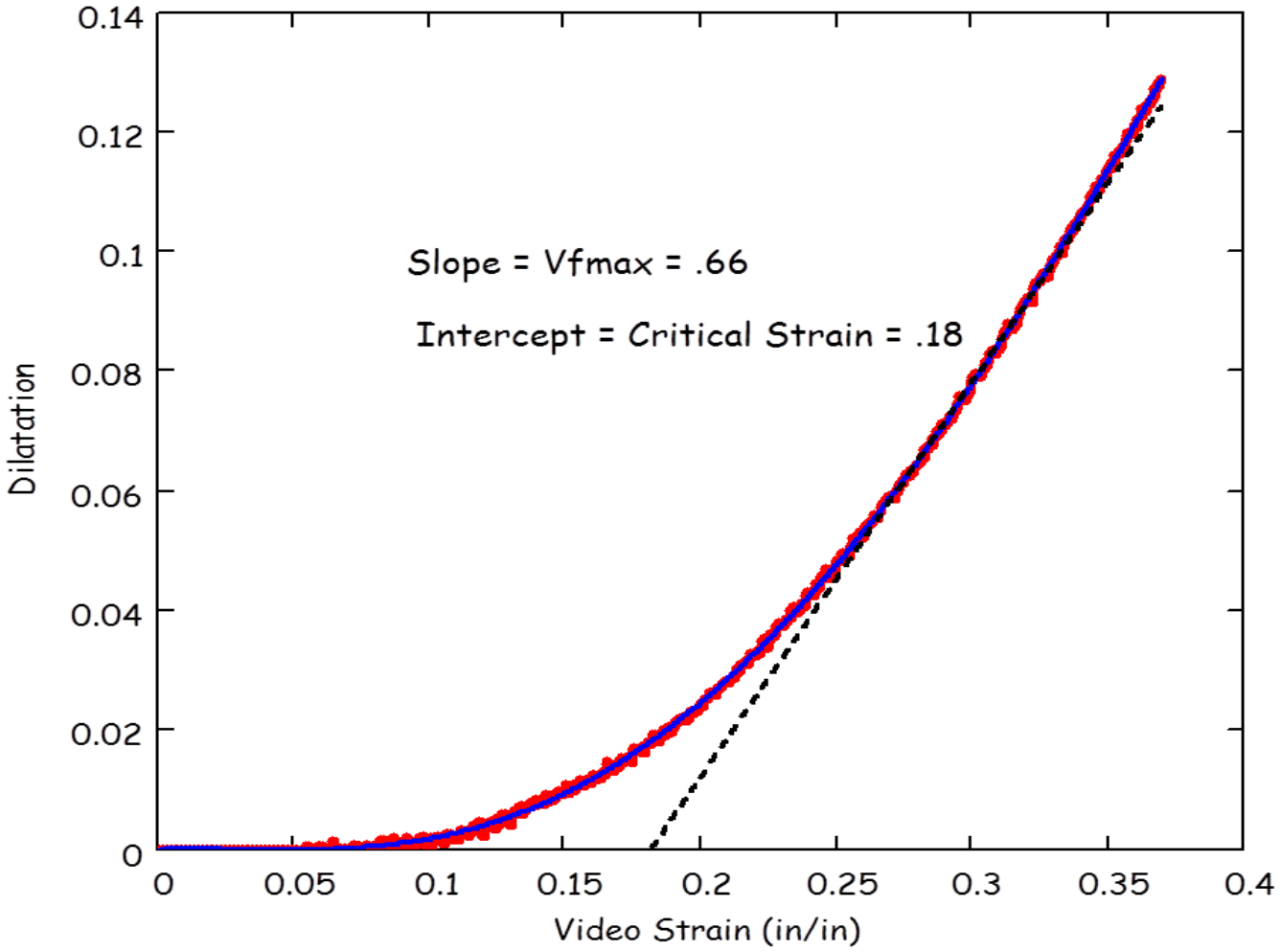
Results

Propellant “A” Dilatation vs. strain from Poisson’s ratio



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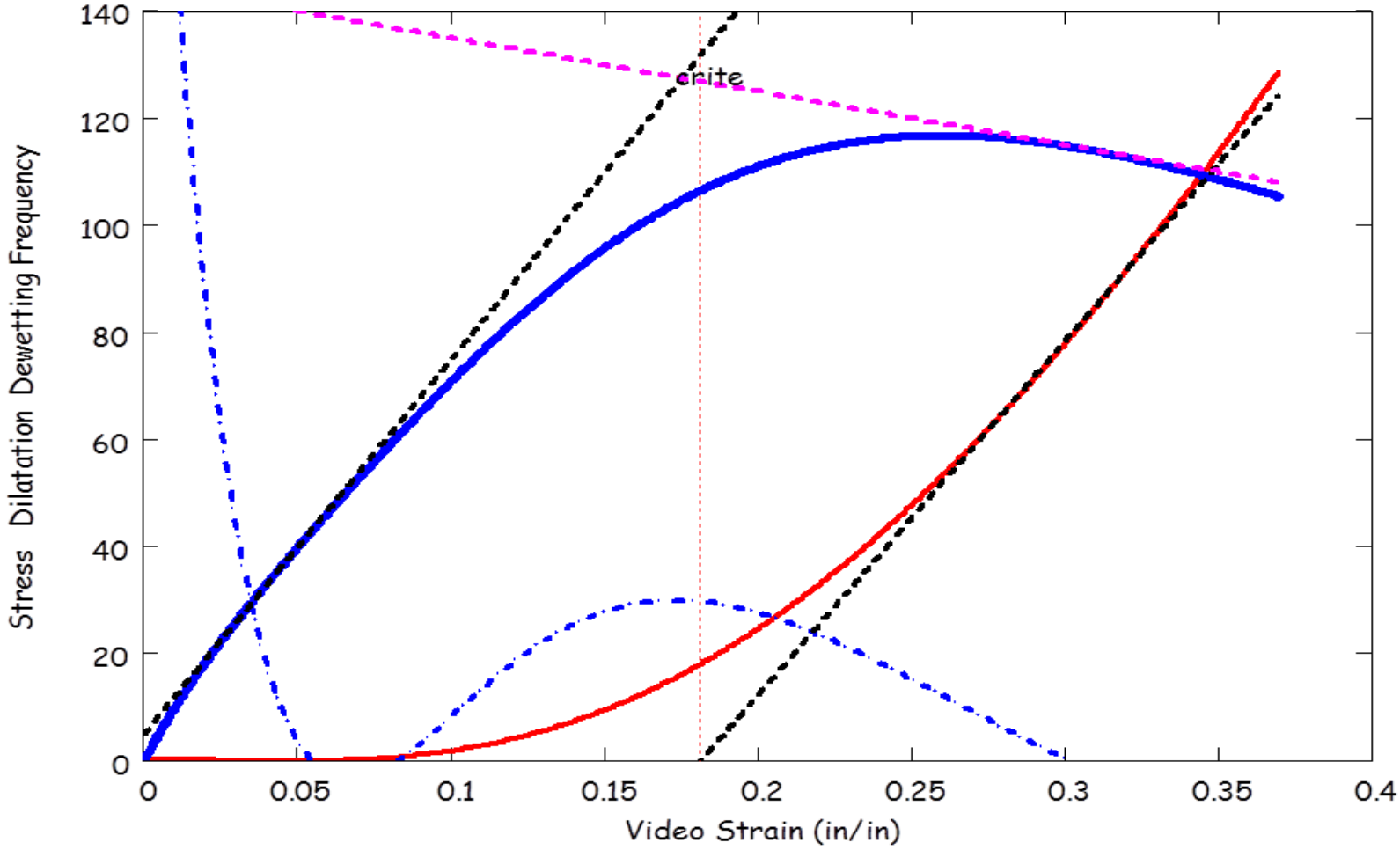
Results

Propellant “A” Fingerprint – Dewetting frequency spectrum



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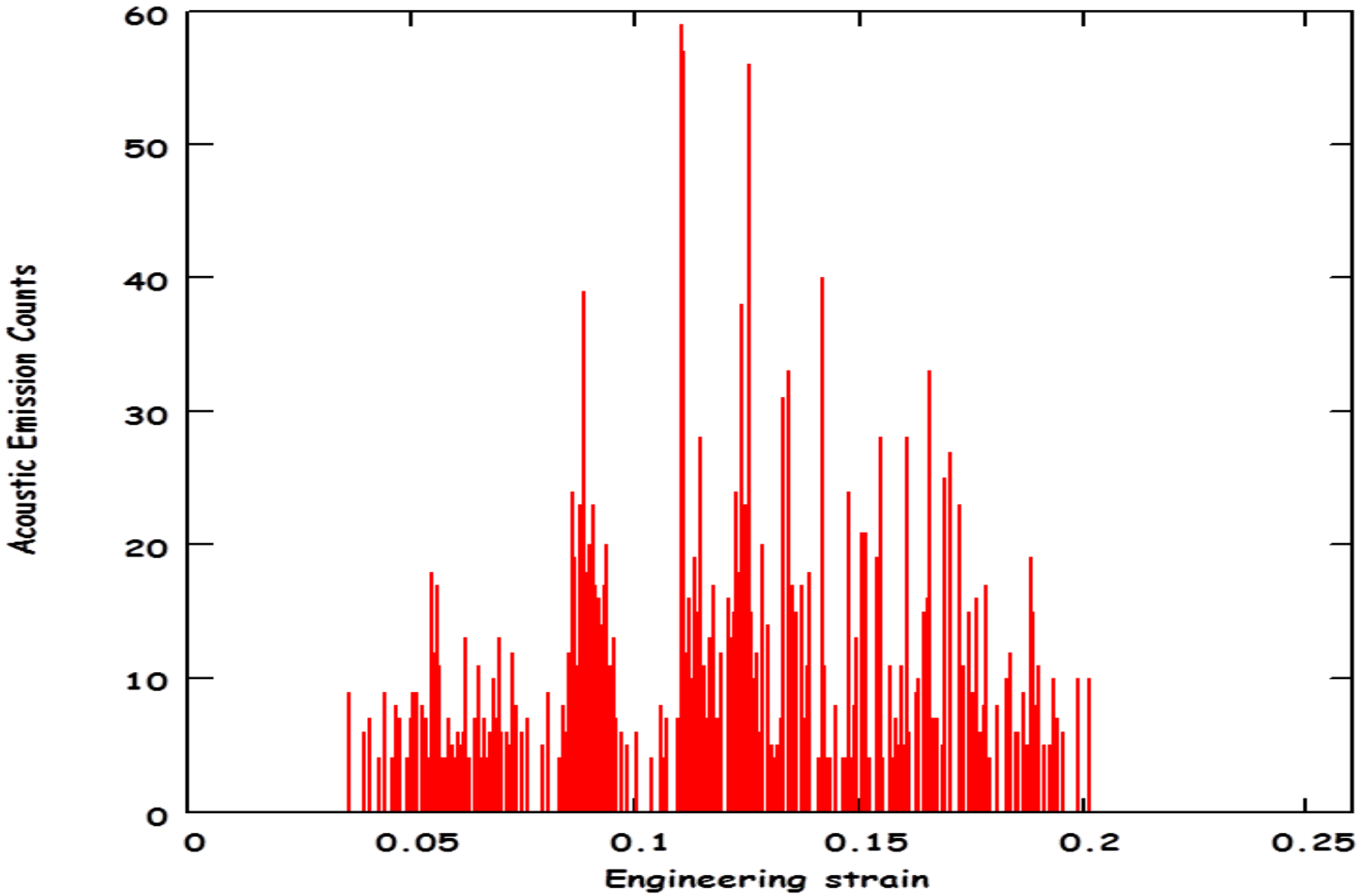
Results

Propellant “A” Dewetting Spectra from Acoustic Emission



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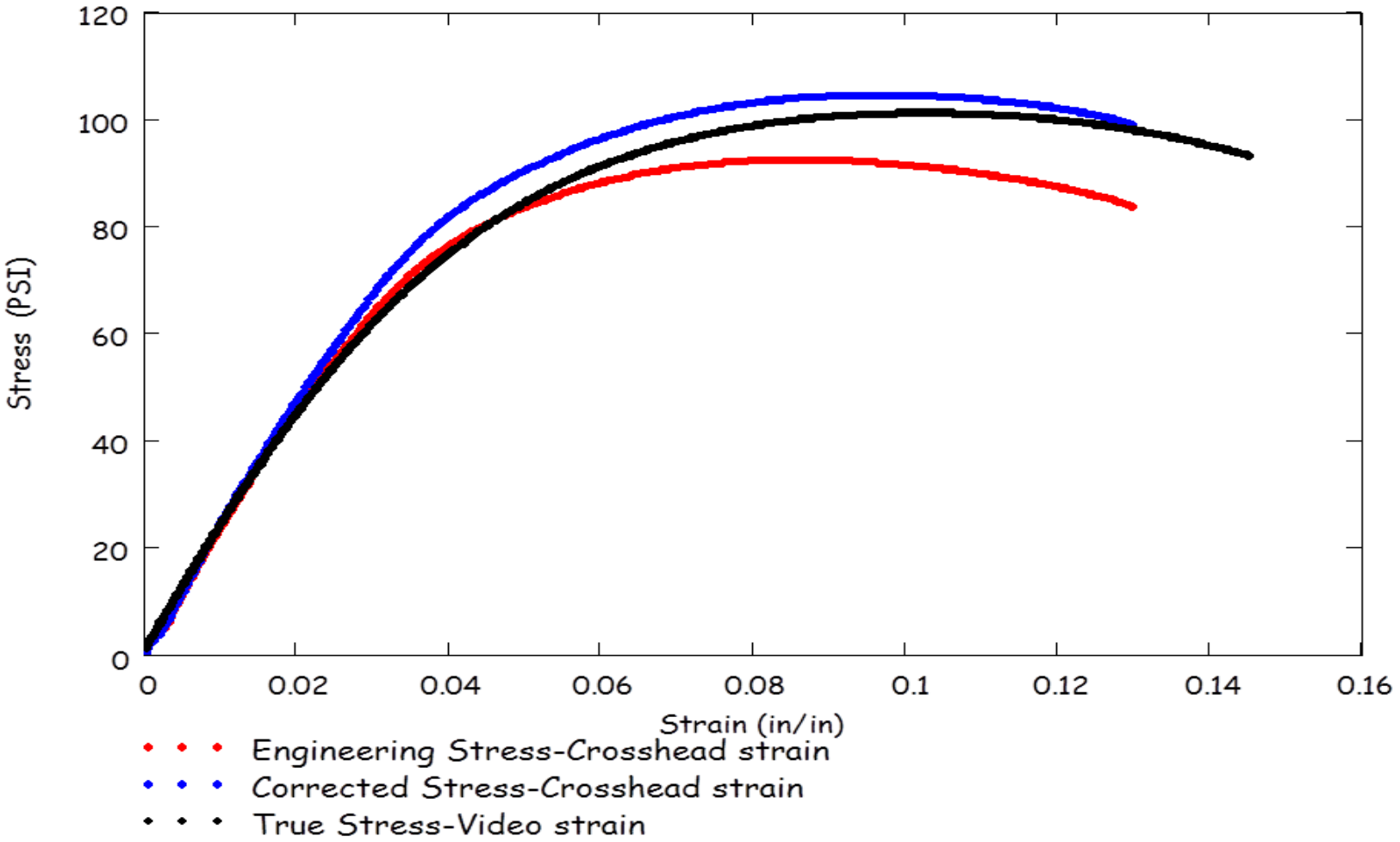
Results

Propellant “B” (HTPB/AP) Stress vs. Strain



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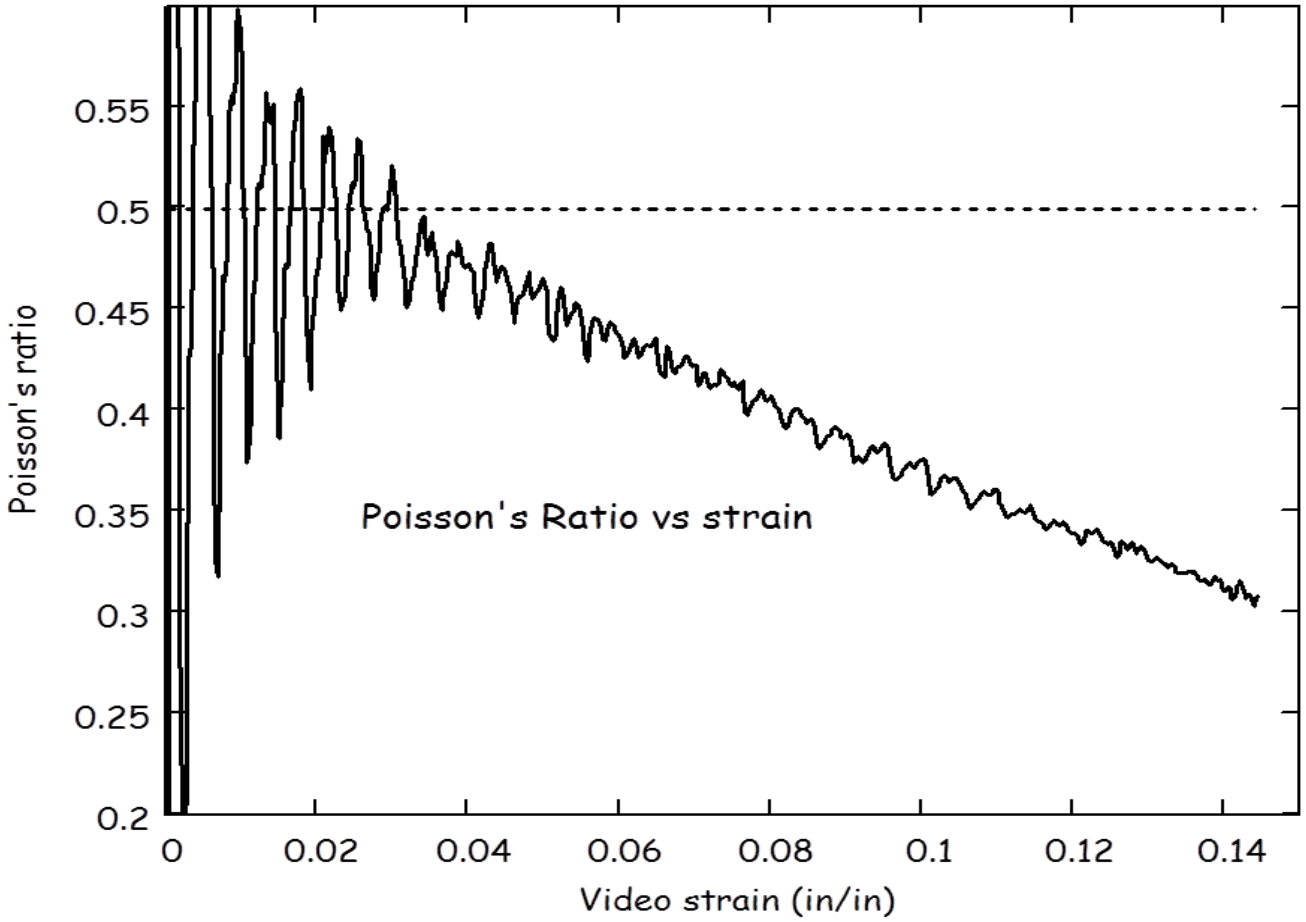
Results

Propellant “B” (HTPB/AP) Poisson’s Ratio vs. strain



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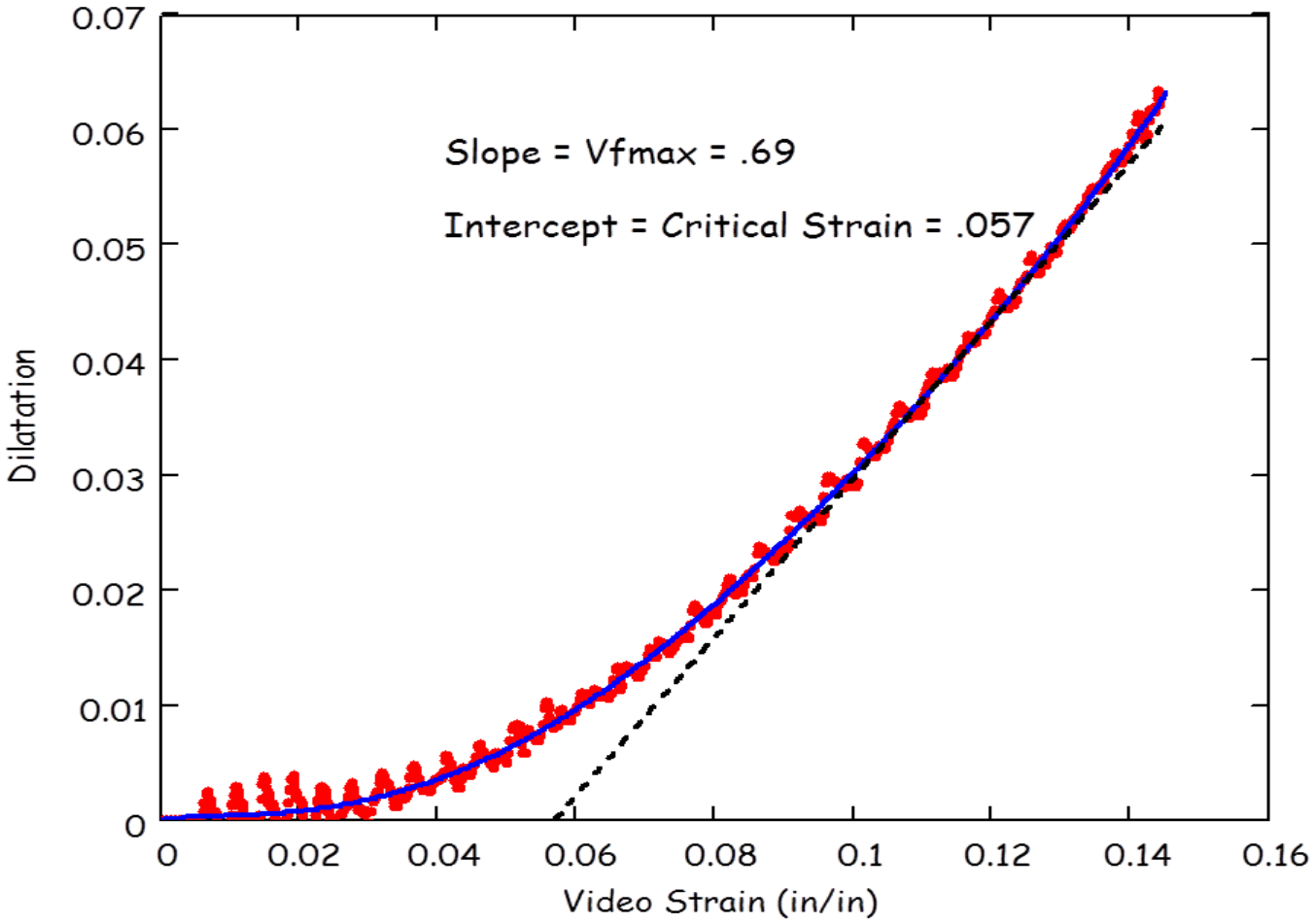
Results

Propellant “B” Dilatation vs. strain from Poisson’s Ratio



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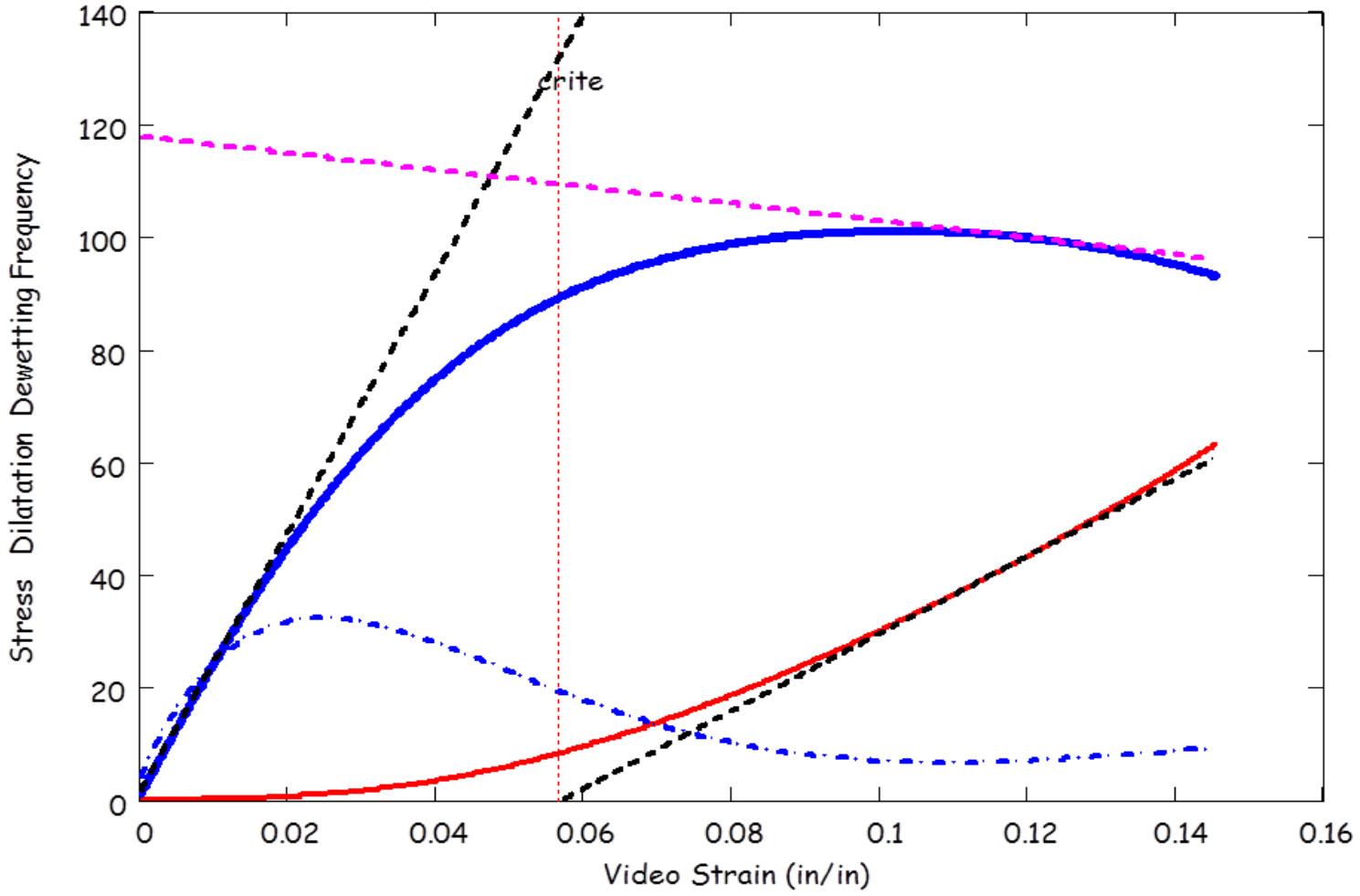
Results

Propellant “B” Fingerprint – Dewetting spectrum



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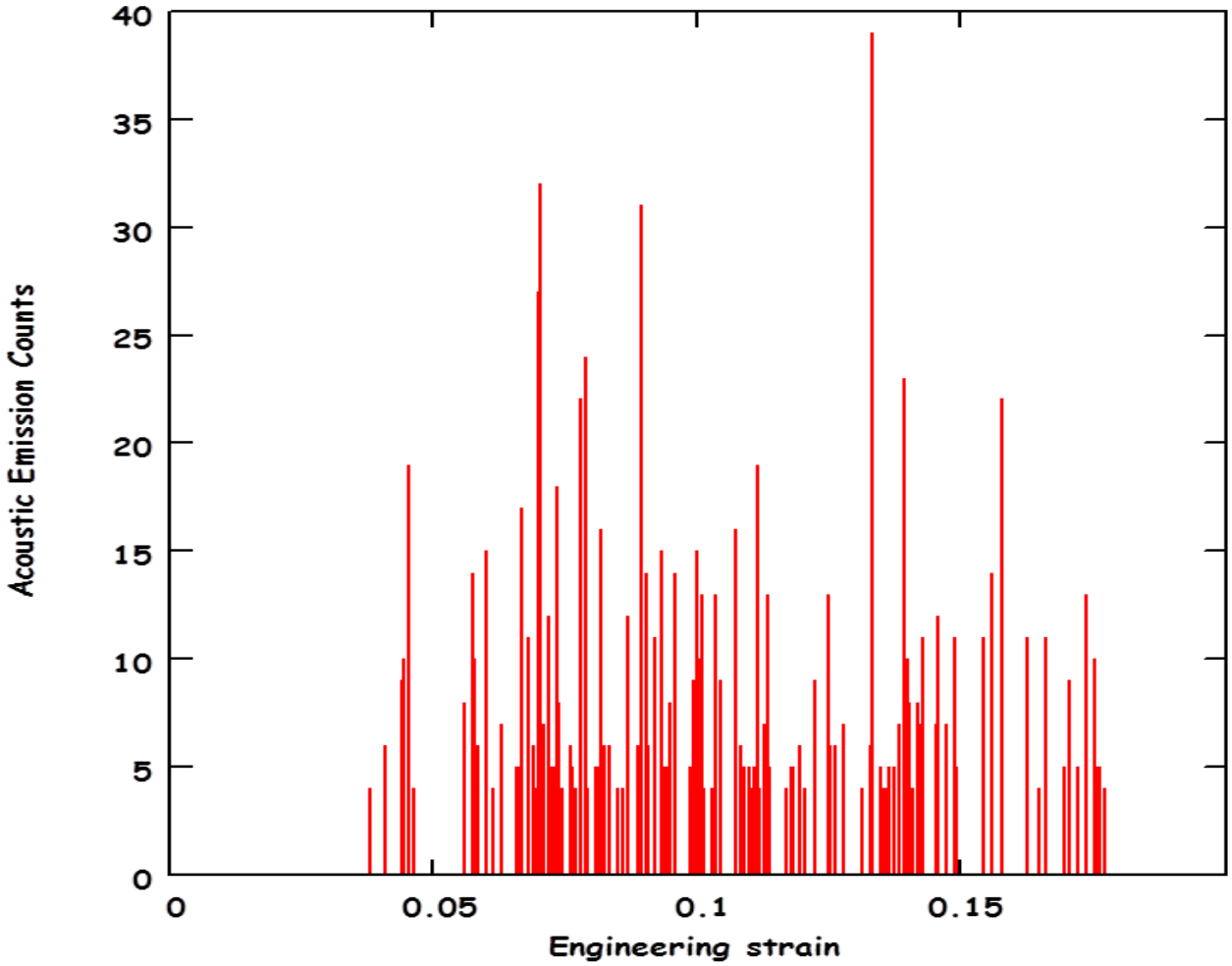
Results

Propellant “B” Acoustic Emission Dewetting Frequency Spectra



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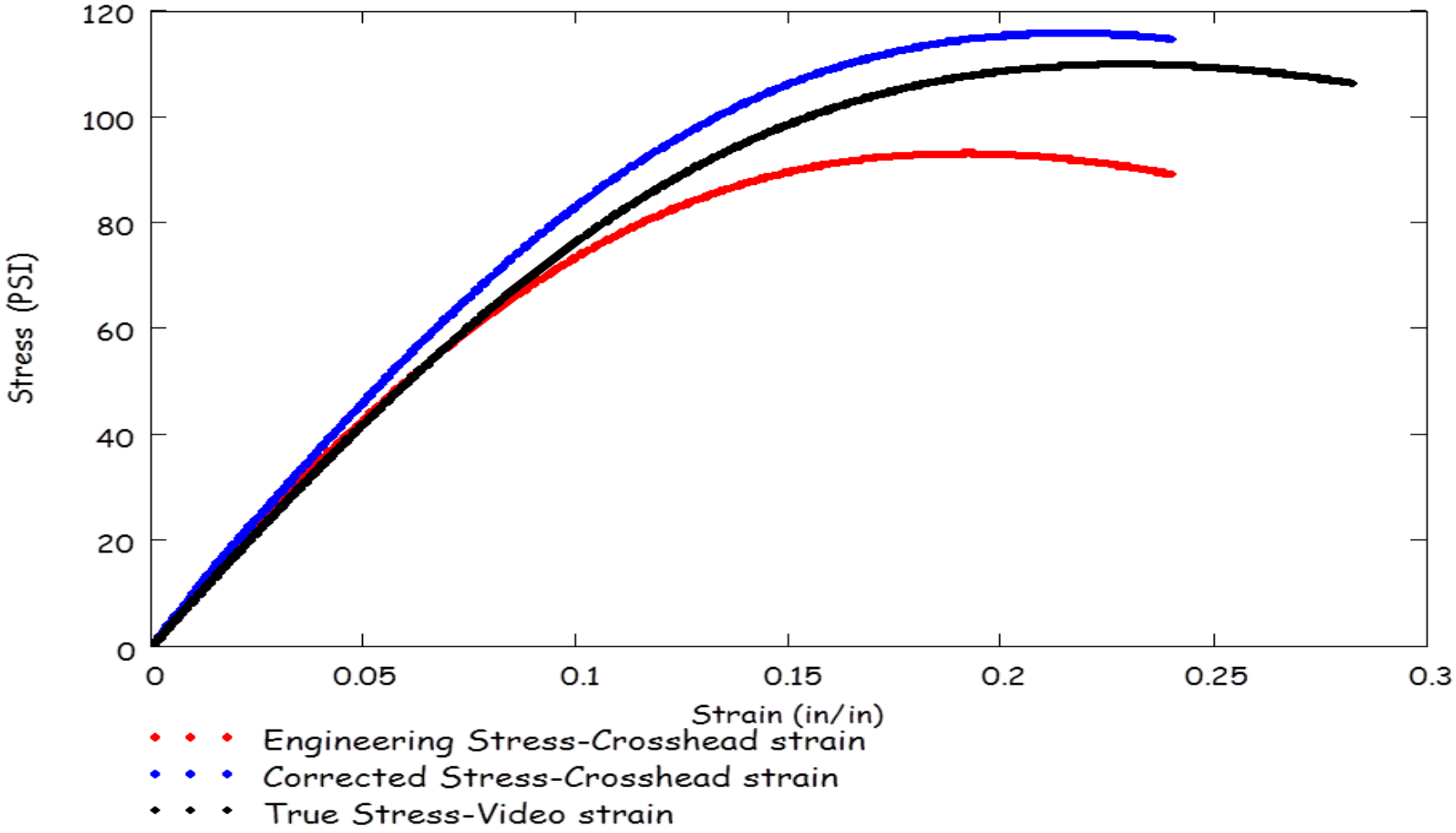
Results

Propellant “C” (HTPB/AP/Al) Stress vs Strain



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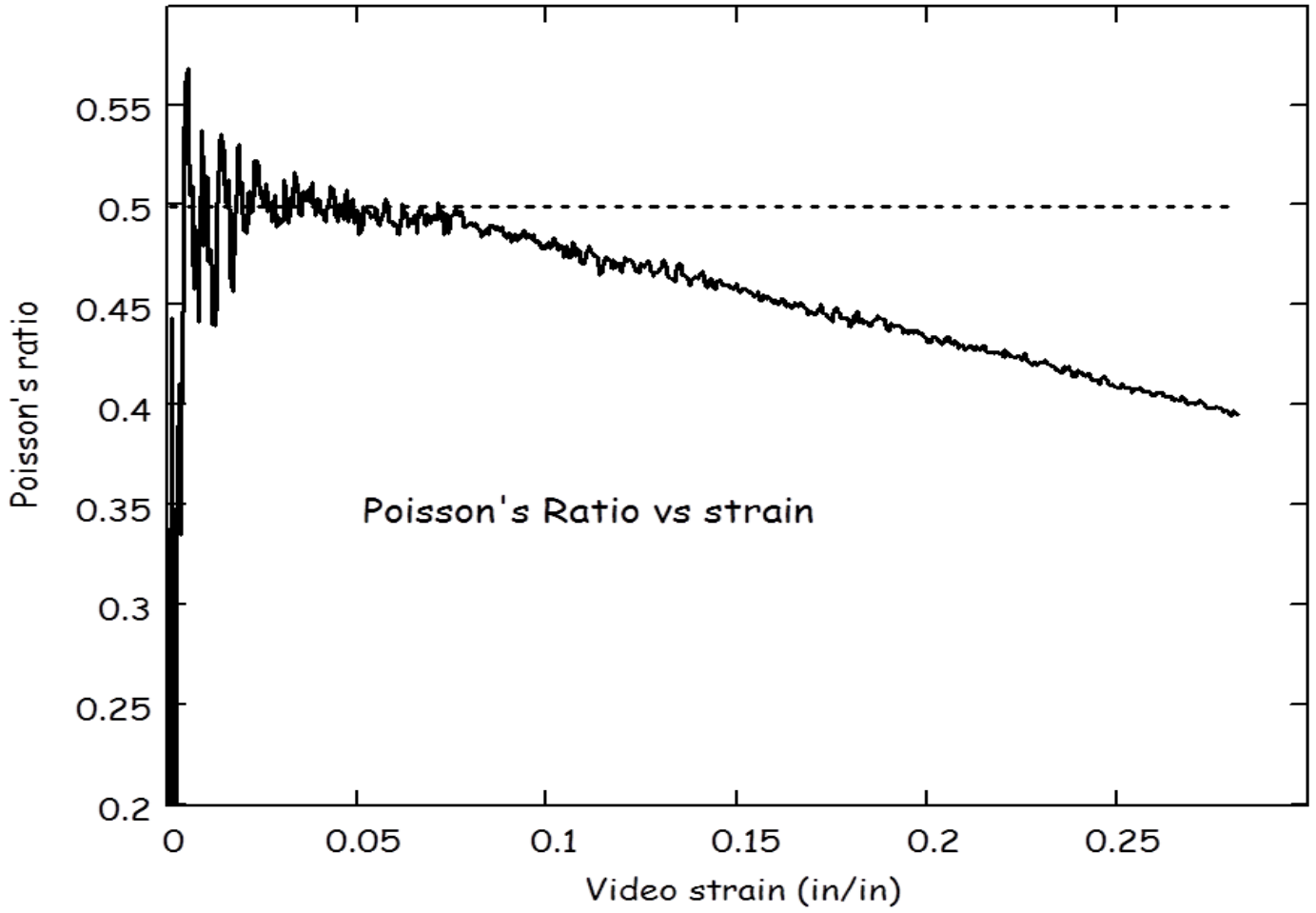
Results

Propellant “C” Poisson’s Ratio



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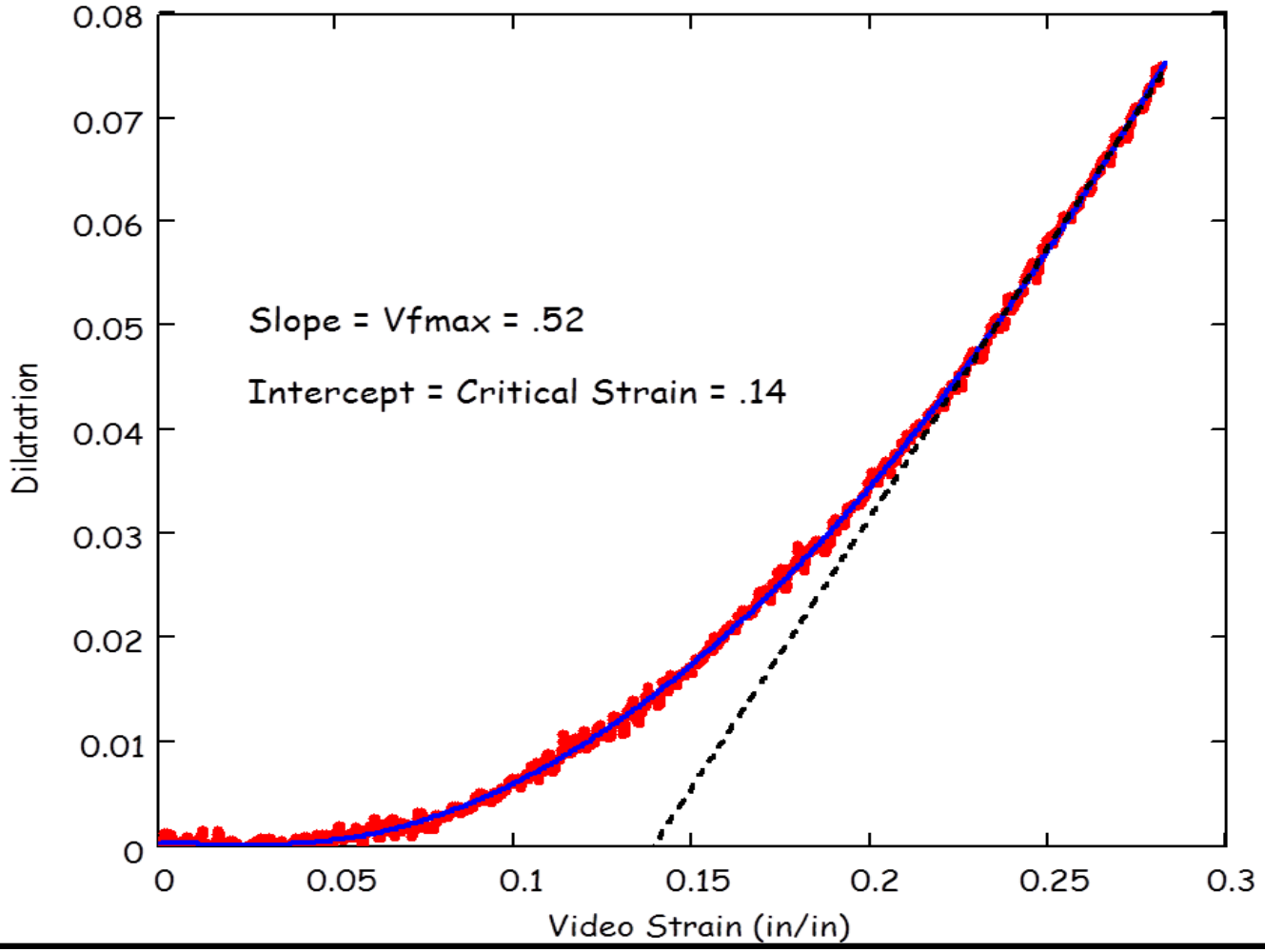
Results

Propellant “C” Dilatation vs. strain from Poisson’s Ratio



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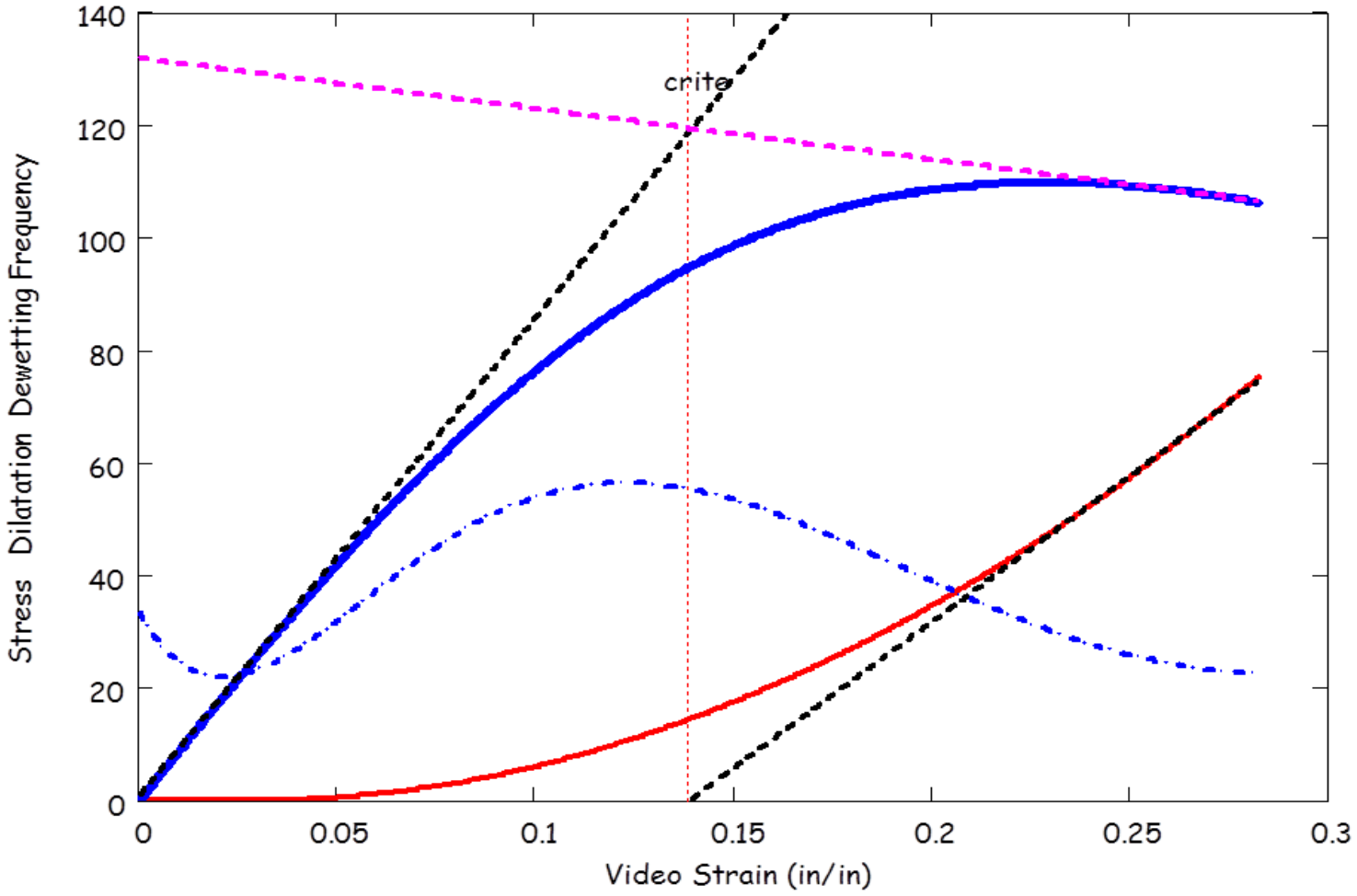
Results

Propellant “C” Fingerprint - Dewetting frequency spectrum



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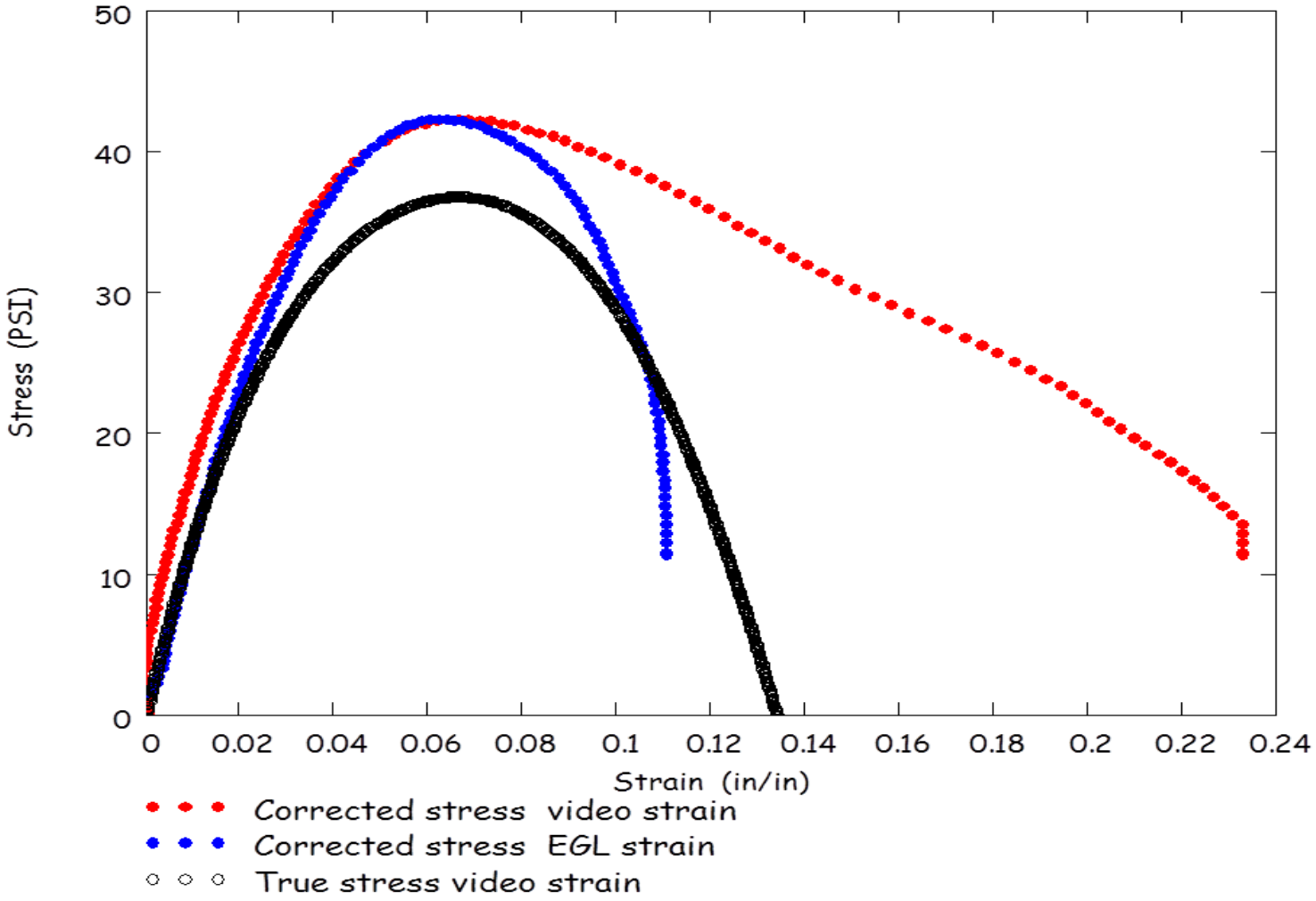
Results

Plastic Bonded Explosive (HTPB/Nitramine) Stress vs Strain



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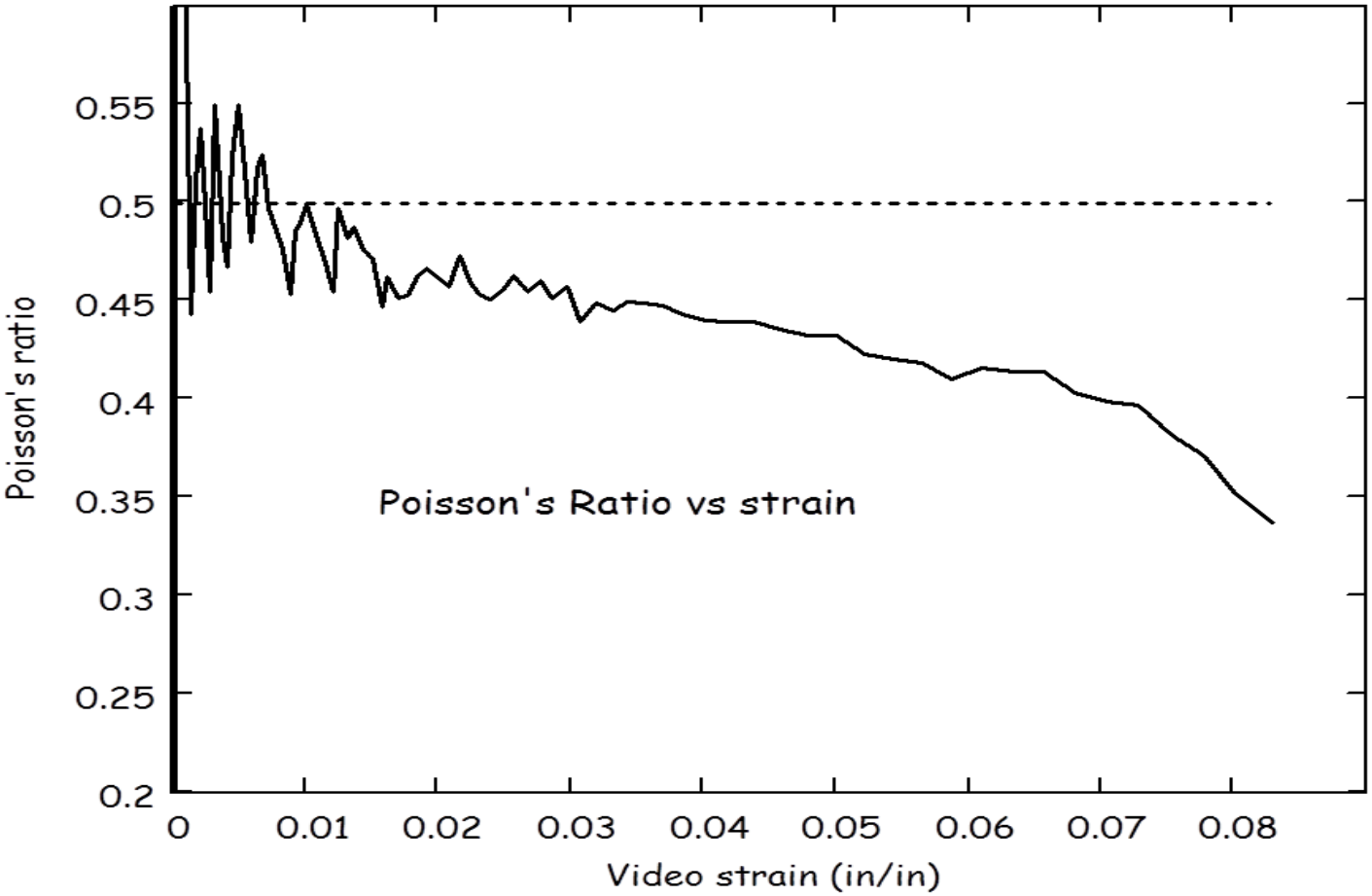
Results

Plastic Bonded Explosive Poisson's Ratio



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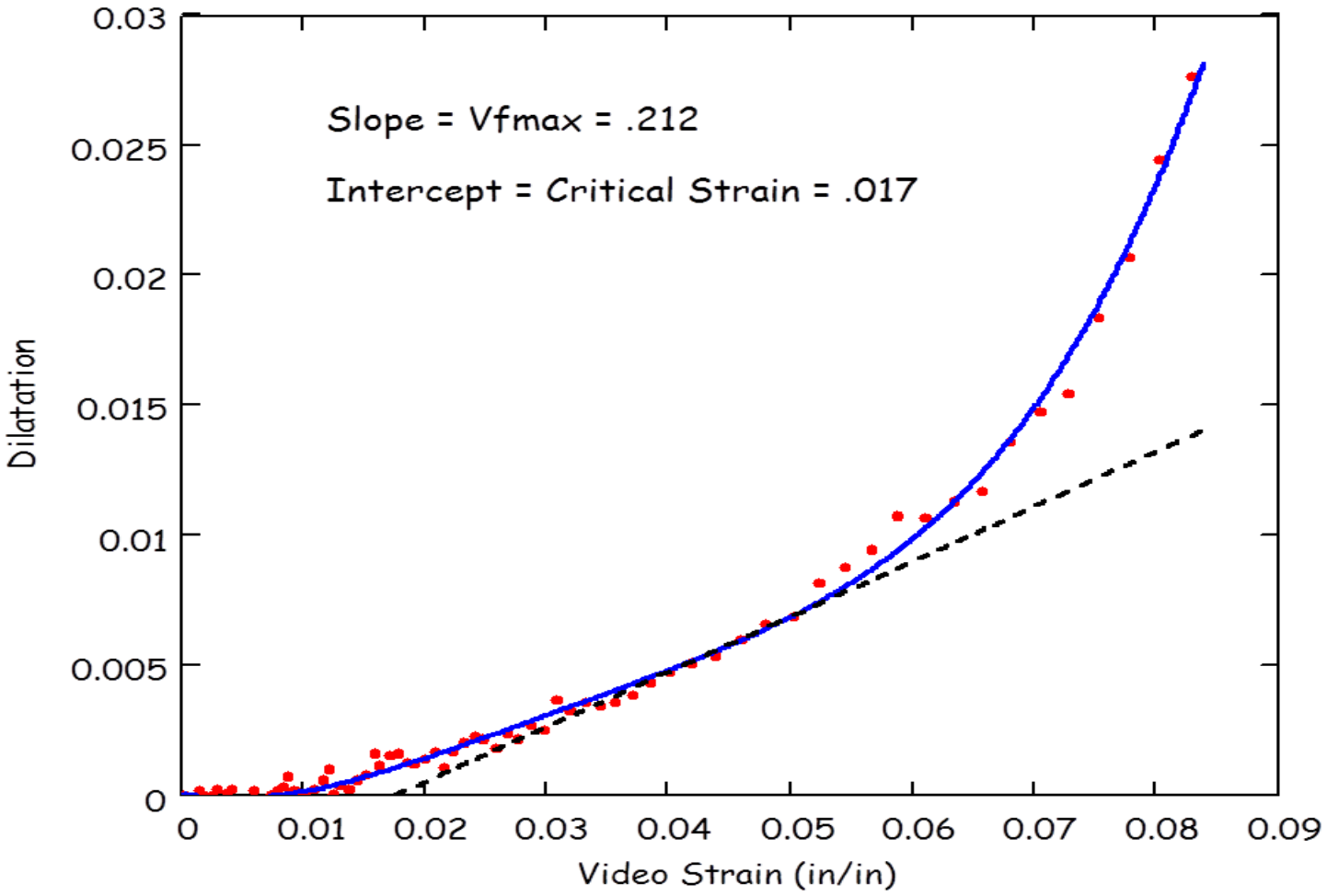
Results

Plastic Bonded Explosive Dilatation from Poisson's Ratio



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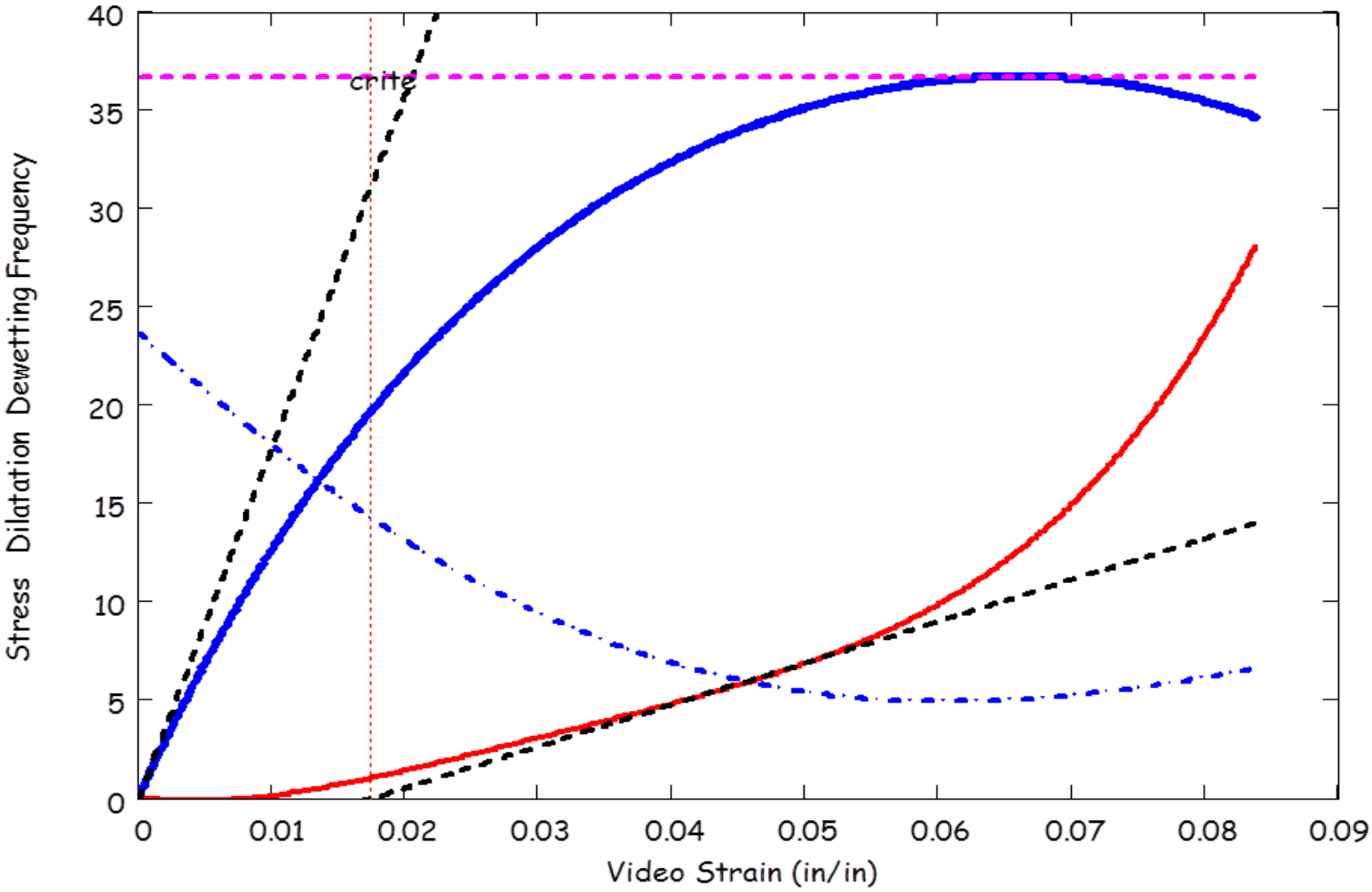
Results

PBX– dewetting frequency spectrum



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Conclusions

- The duel video extensometer can be used to obtain Poisson's ratio as a function of strain.
- Dilatation results can be obtained from Poisson's ratio.
- The dual video Instron can act as a dilatometer.
- True stress closer to corrected stress than engineering stress.
- Dewetting "fingerprints" obtained are in general agreement with Standard Dewetting Model