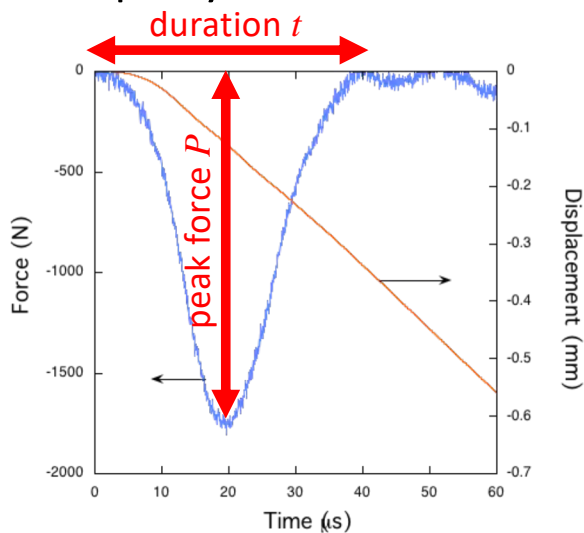


Dynamic fiber push-out

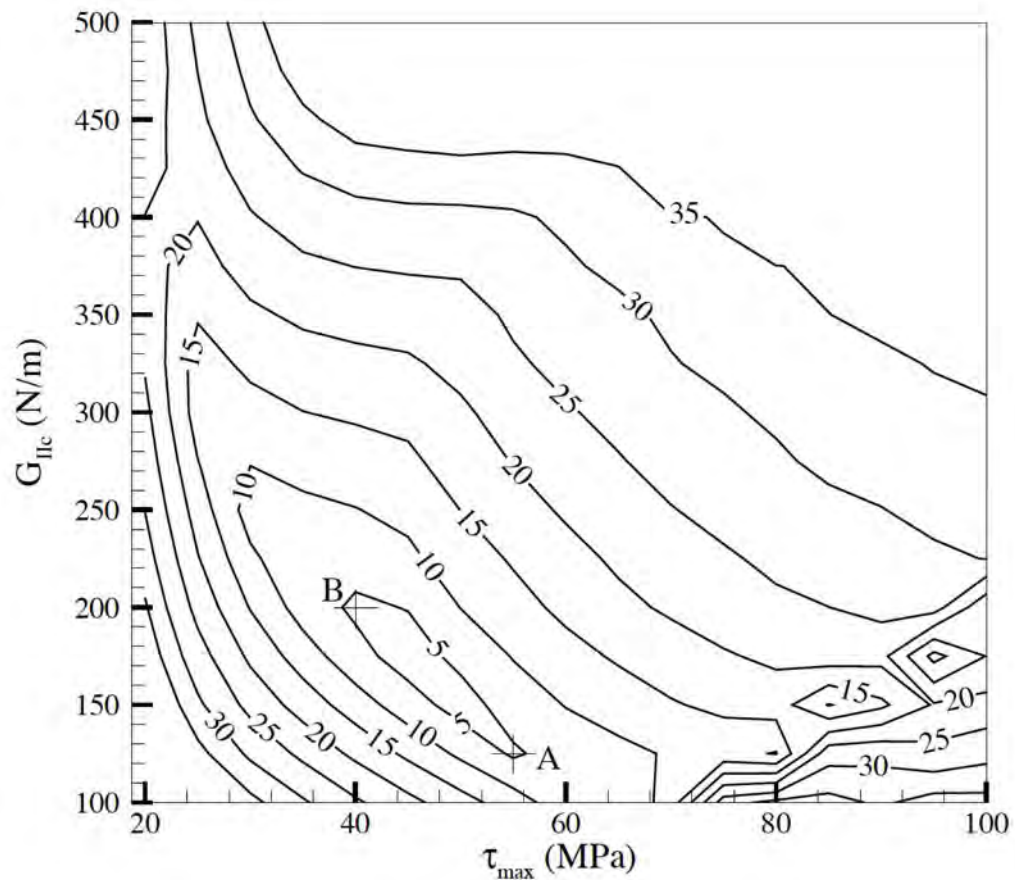
- Property extraction:



$$\varepsilon_P = \frac{P_{num} - P_{exp}}{P_{exp}}$$

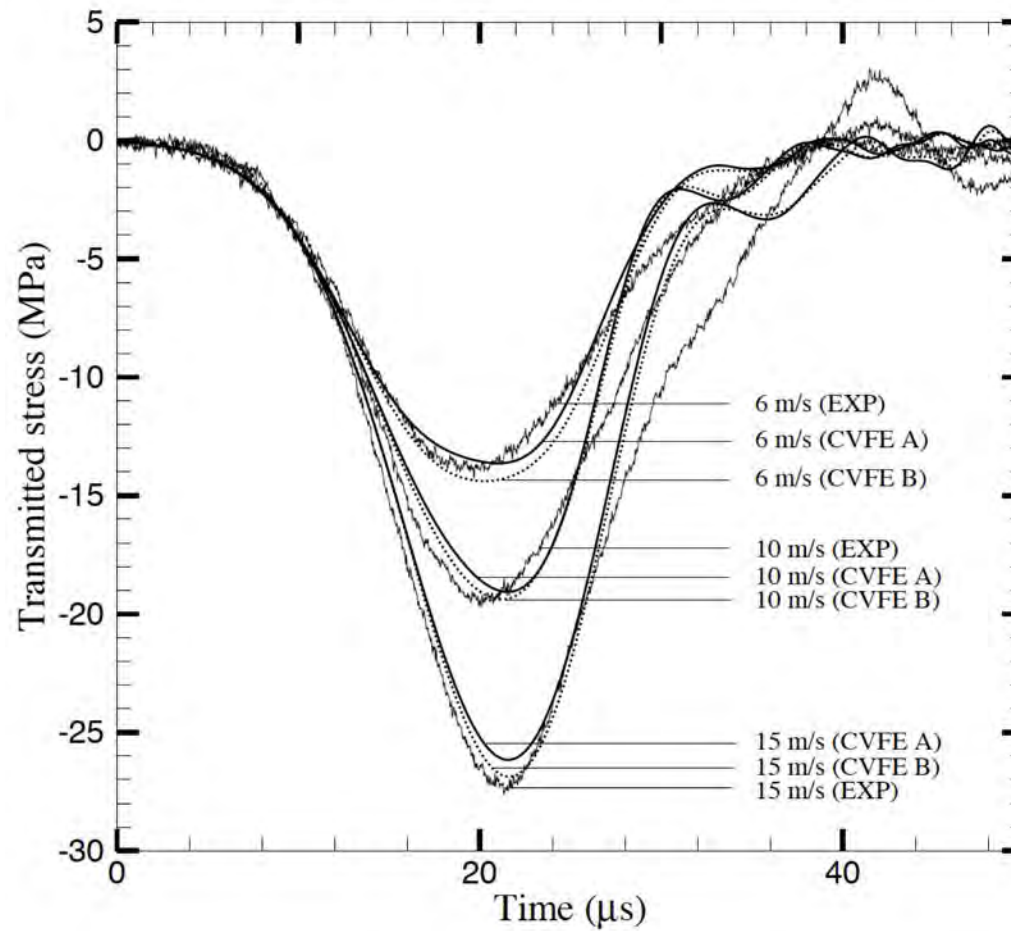
$$\varepsilon = \sqrt{\varepsilon_P^2 + \varepsilon_t^2}$$

$$\varepsilon_t = \frac{t_{num} - t_{exp}}{t_{exp}}$$



Dynamic fiber push-out

- Comparison:



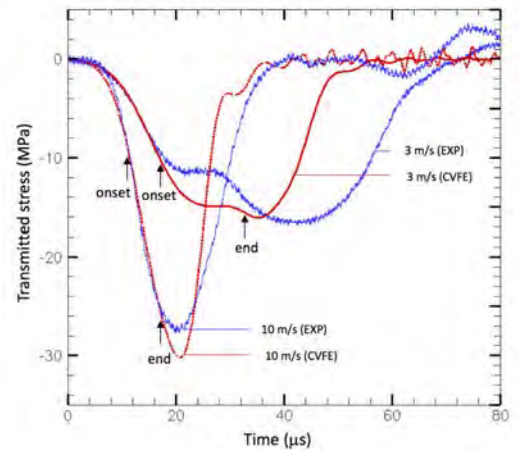
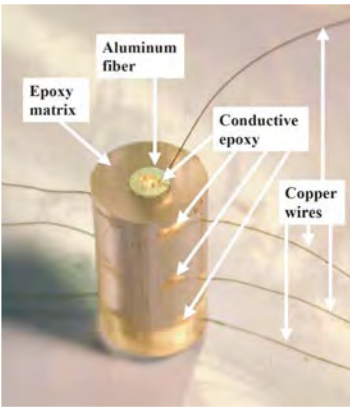
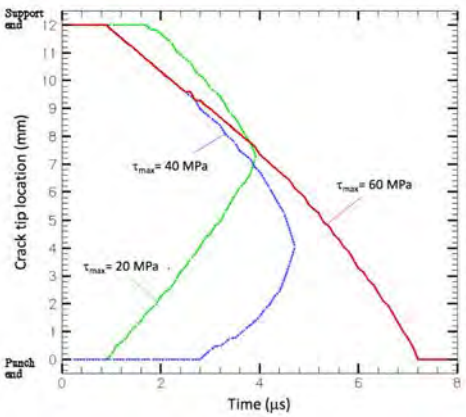
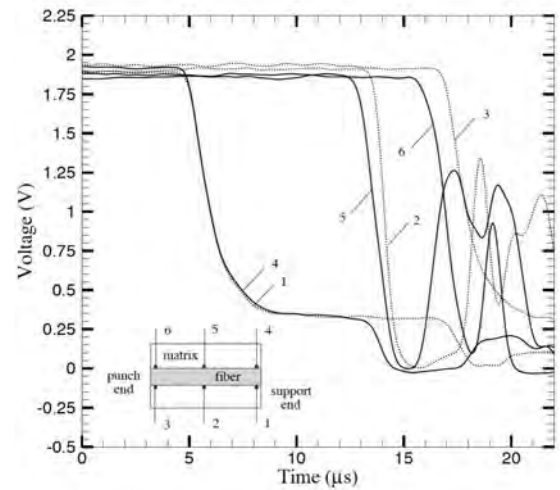
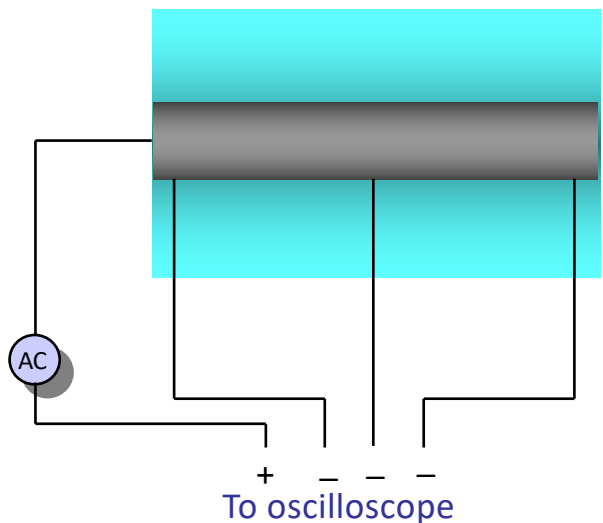
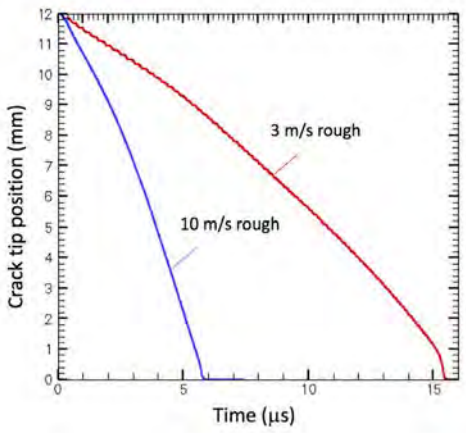
Li et al., *Experimental Mechanics*, 2002

Bi et al., *Mechanics of Materials*, 2002



Dynamic fiber push-out

- “Closing the loop”:



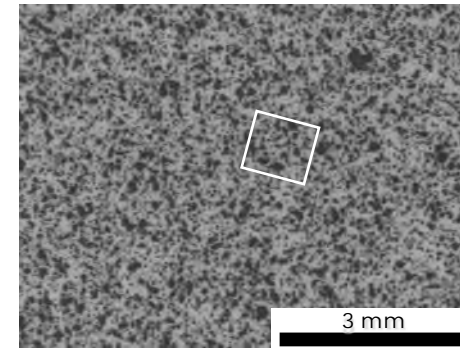
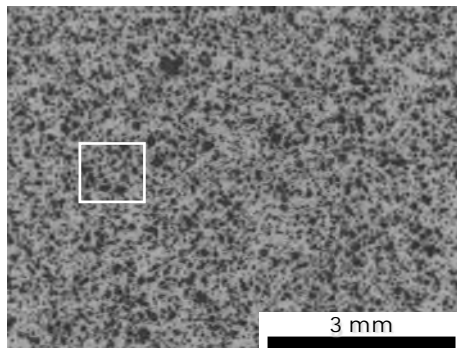
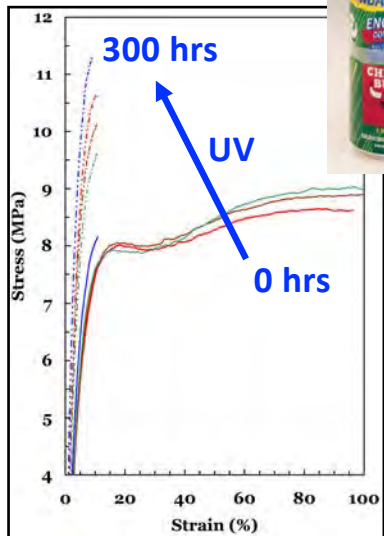
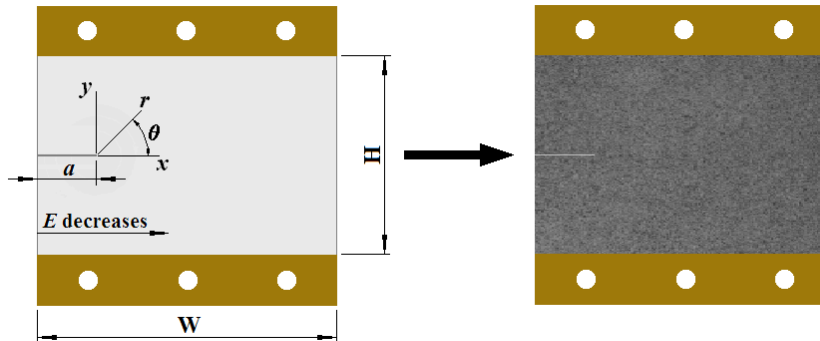
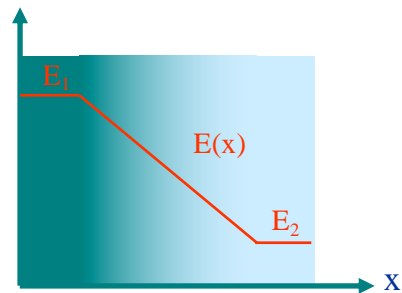
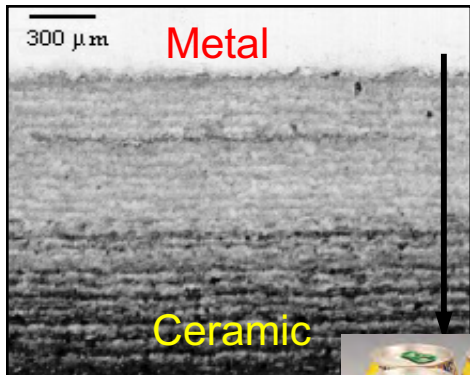
Outline

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- Boundary measurements:
 - Dynamic shear cracking
- **Cohesive properties:**
 - **Full-field measurements**
 - Inverse problem extraction
- Coupled problem: Thermoacoustic fatigue
 - Image decomposition methods

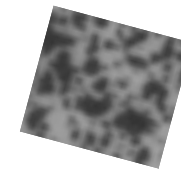


Functionally Graded Materials



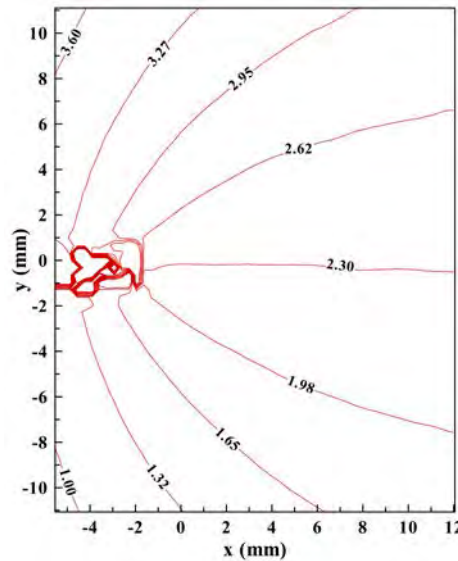
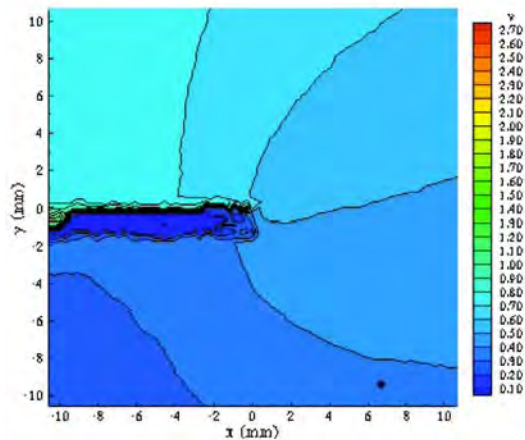
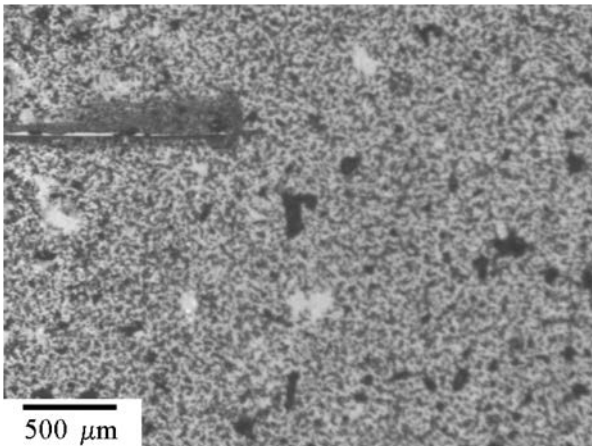
$$x'_q = x_q + u_{x_p} + \frac{\partial u_{x_p}}{\partial x} \Delta x_q + \frac{\partial u_{x_p}}{\partial y} \Delta y_q$$

$$y'_q = y_q + u_{y_p} + \frac{\partial u_{y_p}}{\partial x} \Delta x_q + \frac{\partial u_{y_p}}{\partial y} \Delta y_q$$



Functionally Graded Materials

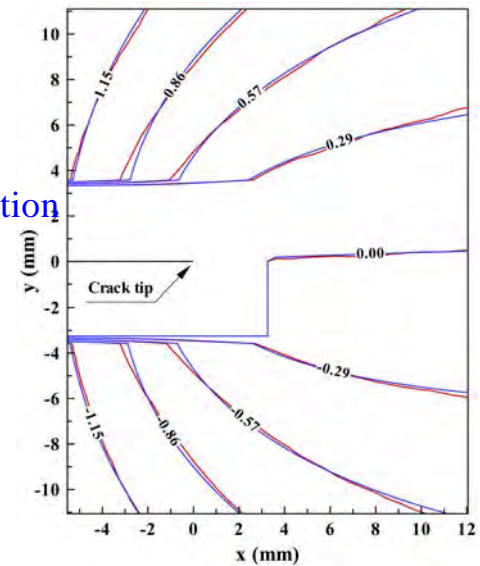
- Full-field information for property measurement:



- LSQRS minimization



Measured u_y
Theoretical u_y



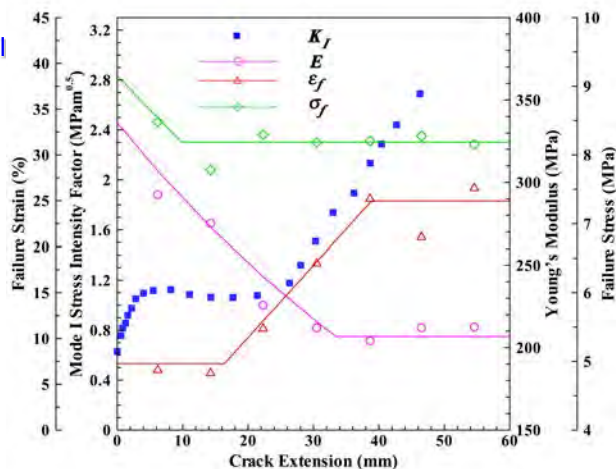
$$u_y = \underbrace{\frac{K_I}{2\mu_{tip}} \left(\frac{r}{2\pi} \right)^{\frac{1}{2}} \sin \theta \left(\frac{3 - \nu_{tip}}{1 + \nu_{tip}} - \cos \theta \right)}_{\text{Mode I loading}} - \frac{T\nu_{tip}}{2\mu_{tip}(1 + \nu_{tip})} r \sin \theta + \underbrace{A_1 r \cos \theta + u_{0,y}}_{\text{Rigid body motion}}$$



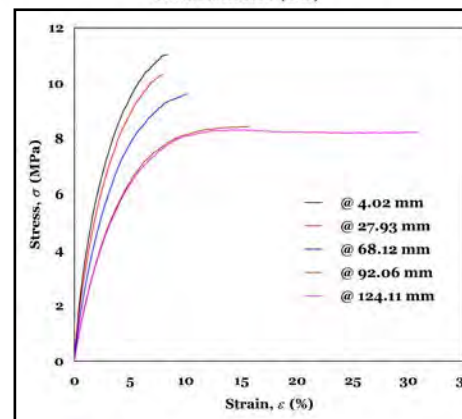
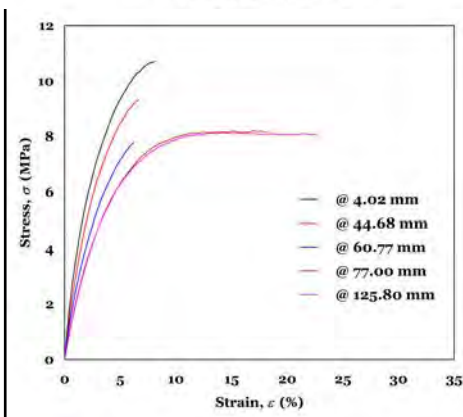
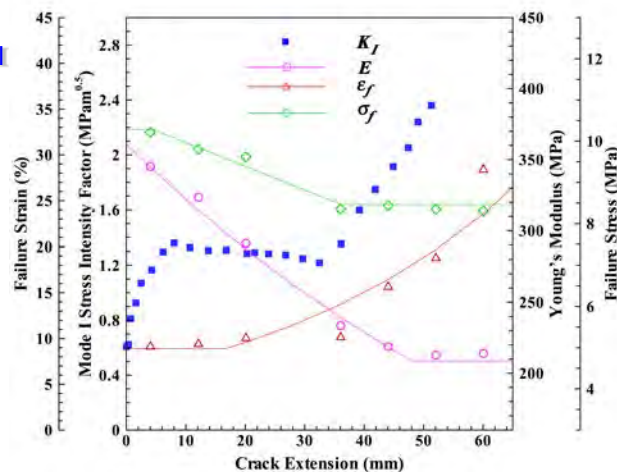
Functionally Graded Materials

- Full-field information for property measurement:

→ FGM I



→ FGM II

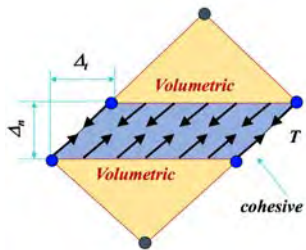
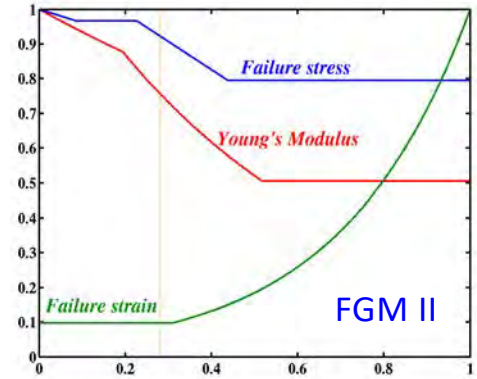
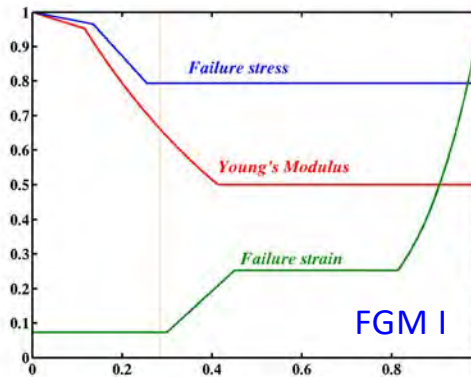
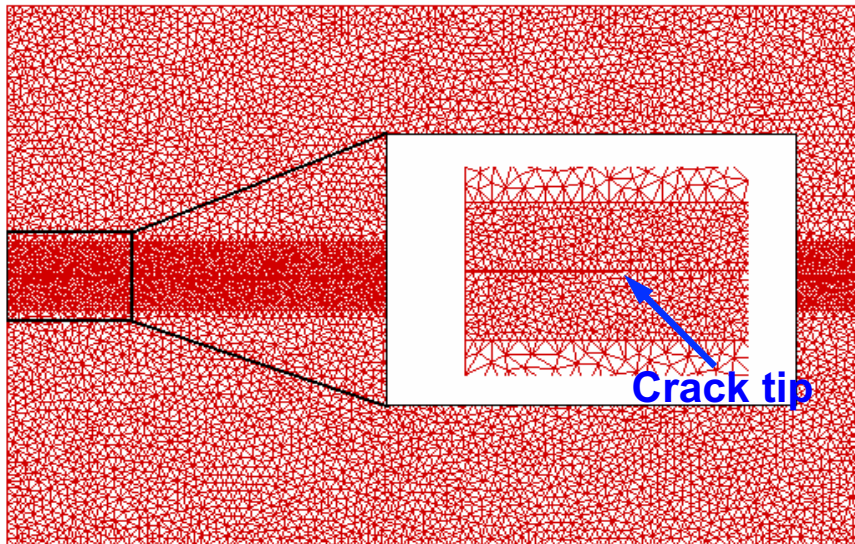


Abanto-Bueno, Lambros, Int. Journal of Solids and Structures, 2006

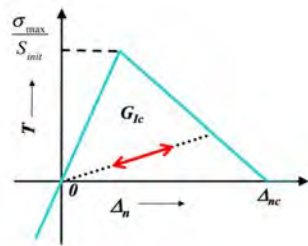


Functionally Graded Materials

• Simulations:



Cohesive element

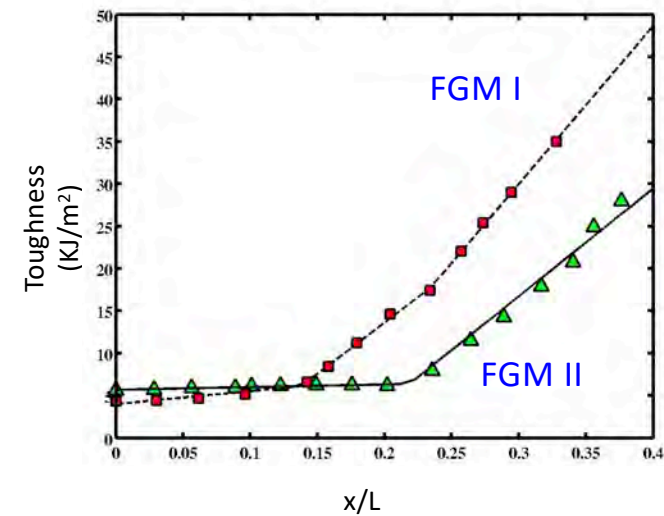


Traction-separation relation

$$T_n = K_c \Delta_n$$

$$K_c = \frac{S}{1-S} \frac{\sigma_{max}}{S_{init}} \frac{1}{\Delta_{nc}}$$

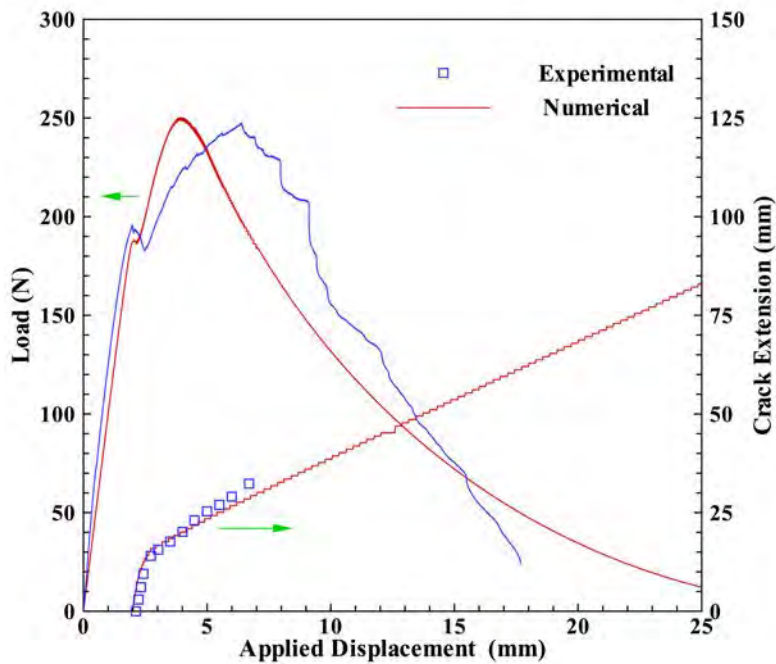
$$S = 1 - \frac{\Delta_n}{\Delta_{nc}}$$



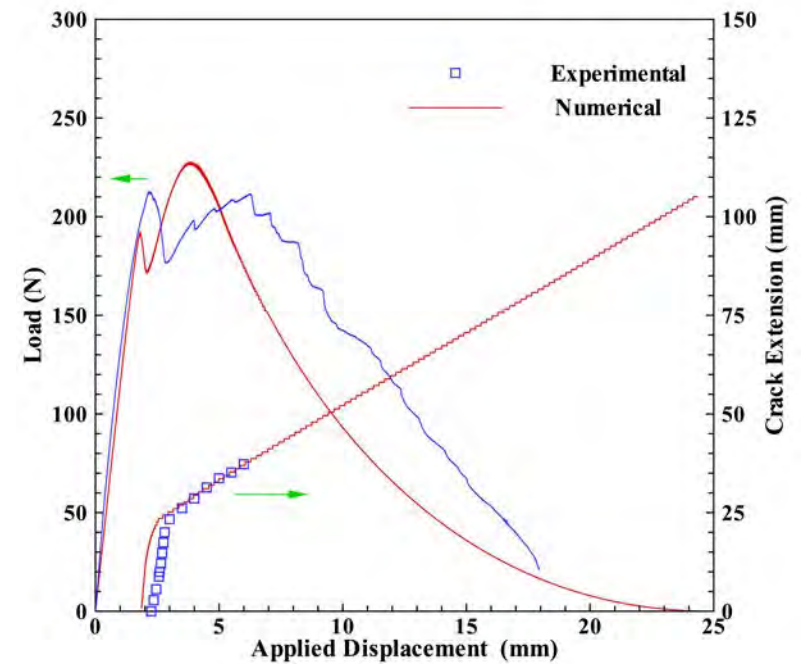
Functionally Graded Materials

- Validation:

FGM I



FGM II



Outline

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- Boundary measurements:
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