Modified Decohesion Test (MDT) to Determine Interfacial Fracture Toughness in Thin Metal Films

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OBJECTIVE
- To characterize interfacial fracture toughness of thin film metal interfaces for the prediction and/or design against interfacial delaminations in electronic and MEMS packages.
- To develop a test that can meet the requirements of:
  - Toughness can be measured using a single sample
  - Any mode mix can be generated
  - Sample preparation is simple
  - A mechanics based analytical solution exists
  - A representative interface is created (i.e. use IC fabrication techniques)

ACCOMPLISHMENTS:
- Created an analytical model to calculate energy release rate for intrinsically stressed, thermally loaded, anisotropic thin film plates.
- Developed, validated, and patented MDT (Provisional Patent GTRC ID 2682 for Modified Decohesion Test, May 2002).
- Measured interfacial fracture toughness for a Ti/Al$_2$O$_3$ interface for a mode mix of 14°
- Applied Ti/Al$_2$O$_3$ interfacial toughness measurement to a numerical parametric study addressing changes in an adhesive metal layer to help prevent delamination in stress engineered high density interconnect applications.

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APPROACH
- Using IC fabrication techniques test strips are fabricated on a substrate creating the interface
- Crack surface area is varied for each test strip such that many energy release rates are created on a single test sample
- A highly stressed super layer is used to cause delamination
- The energy release rate below and above the point of delamination are used to bound the interfacial fracture toughness
- Test parameters (film thickness, super layer stress, test strip width, etc.) are correlated to the energy release rate using a mechanics based analytical solution