A geometry for interface fracture analysis at the micron scale

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Motivation & Methodology

- Interface failure / delamination at small length scales are currently studied using quantitative based methods.
- These methods are prone to experimental imperfections associated with testing geometries and load application.
- We propose a new cantilever-based geometry for interface fracture meausrements at small length scales.

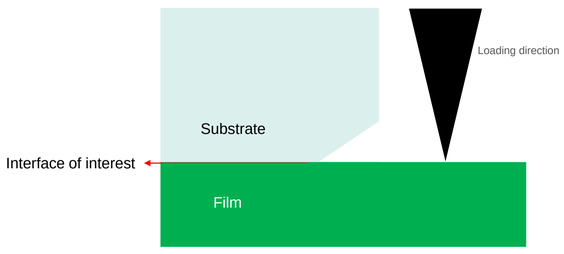


Fig. 1 – Proposed cantilever-based geometry for analysis of single interfaces

- Fabrication of new geometry

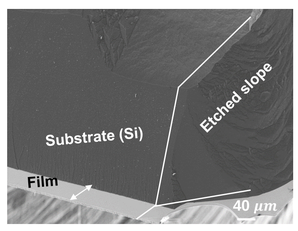


Fig. 2 – Etched sample of (Hf-Nb-Ta-Zr)C film on Silicon substrate

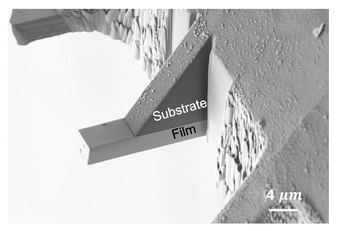
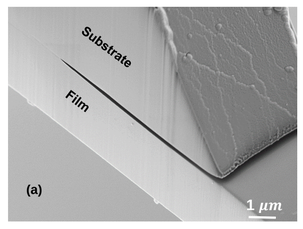


Fig. 3 – FIB fabricated test geometry



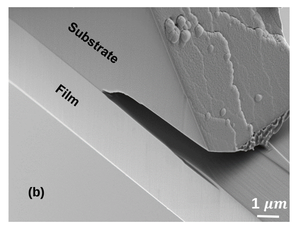


Fig. 4 – Notches milled into the cantilever; through width notch (a) and chevron notch (b)

- Test Setup

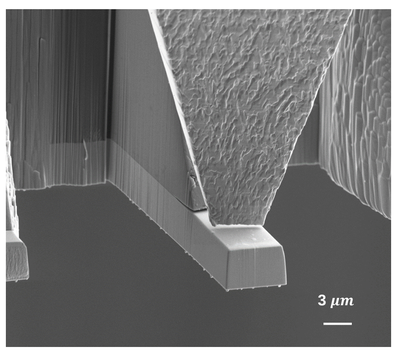


Fig. 5 – *in situ* test set up using a wedge tip microfabricatedd in-house

Results

Two dimenisonal Finite Element Simulations: Contour Integral

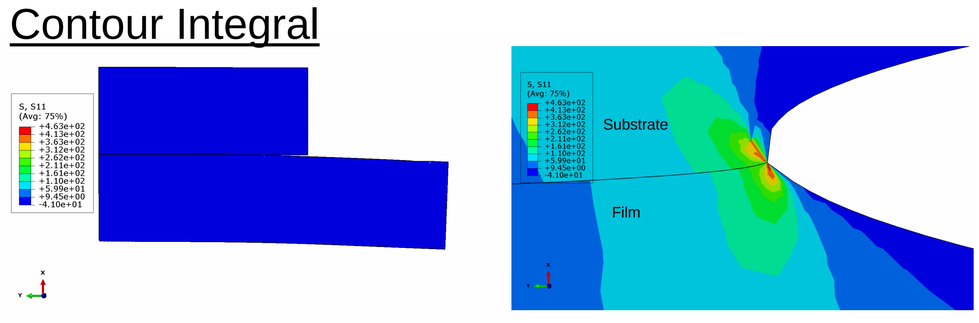


Fig 6.– Deformed geometry with homogeneous material system

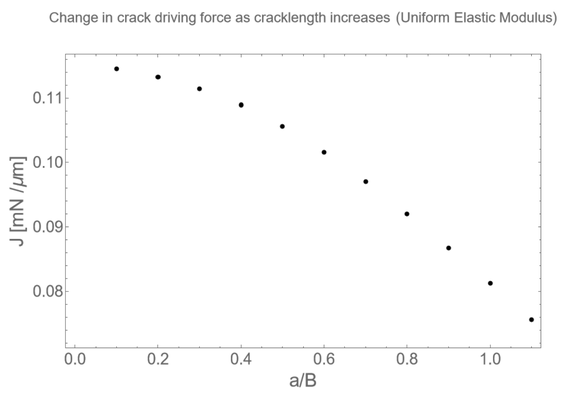


Fig 7– Crack driving force vs cracklength of homogeneous material system

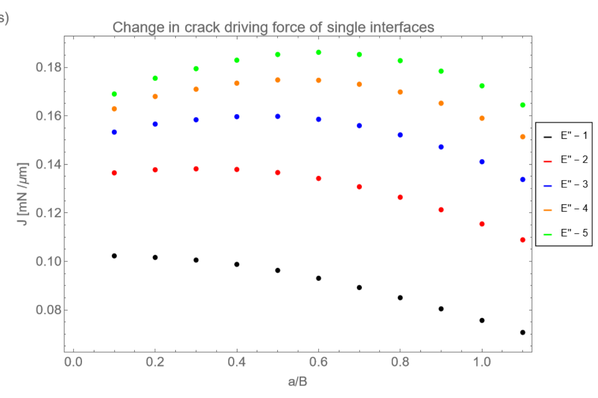


Fig 8.– Crack driving force in bimaterial interface; with increasing elastic modulus of film.

J	Energy release rate
a/B	crack to Beam thickness ratio
Ef	Elastic modulus of film
Es	Elastic modulus of substrate
E'	Ef / Es

In situ test of interfaces using new geometry

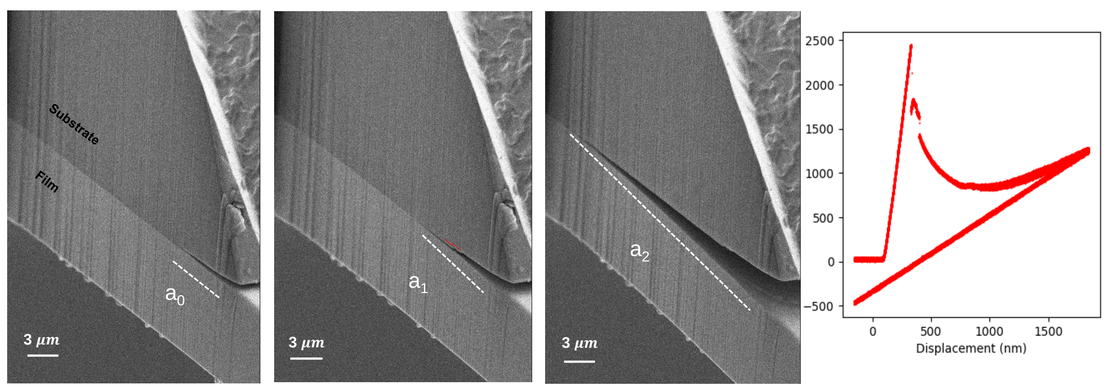


Fig 9.– Crack opening along the interface plane of a microcantilever with a through width notch and Load vs displacement curve showing load drop as crack propagates.

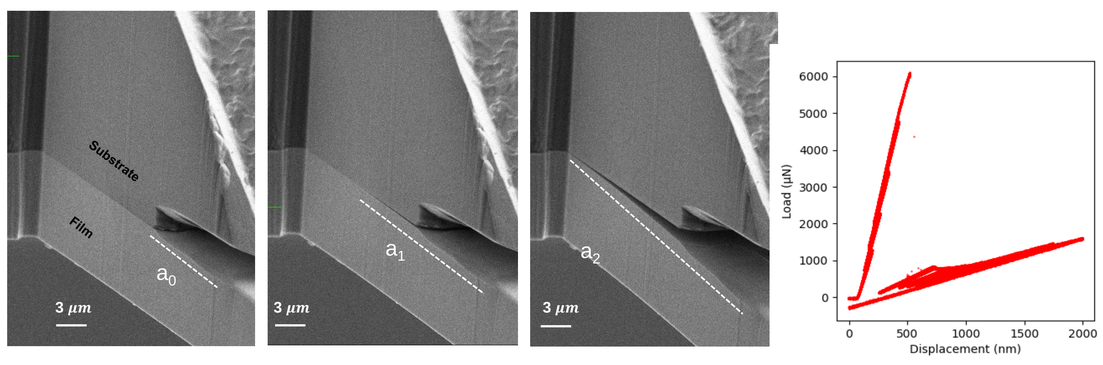


Fig 10.– Crack opening along the interface plane of a microcantilever with a chevron notch and Load vs displacement curve showing partial unloading steps during the test.

Summary

A new cantilever based geometry is introduced for interface fracture investigations:

- FEM and *in situ* testing were used to study the fracture behaviour of the geometry.
- Both simulation and experiments showed stable crack propagation along the interface in the new geometry.

Next Step

- Derivation of fracture mechanics model for quantitfication of mechanical data.

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