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Mechanics of Materials

A new miniature setup for in-situ characterization of interface delamination
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Introduction
Increasing demands for miniaturization and multi-functionality in microelectronics industry lead to the high density integration of several components in a single module (e.g. System In Package (SIP), Fig. 1a). Interfaces present between stacked layers of dissimilar materials often fail by delamination (Fig. 1b).

Aim: Development of a setup, capable of i) testing miniature structures and ii) carrying out in-situ tests for accurate characterization of delamination.

New experimental setup
A new miniature setup (Fig. 2) capable of applying mixed mode bending (MMB) loads and suitable for in-situ testing is designed and manufactured.

Highlights
Precise crack length measurement
Calculation of critical energy release rate of an interface requires precise crack length measurement. In-situ experiments in a scanning electron microscope (SEM), on copper lead frame - molding compound epoxy bilayer samples, showed that precise identification of the ‘crack tip’ (Fig. 3) and hence crack length is possible with an accuracy of $5\mu m$.

Insight of delamination mechanism
Experiments on bilayer steel samples with a glue interface revealed details of the delamination mechanism. Formation of small cracks ahead of the interface is identified before evolution of the actual crack (Fig. 4). For this particular interface these small cracks are seen over a distance of $\sim50\mu m$ ahead of the crack tip.

Critical energy release rate (CERR) measurement
The CERR is calculated from the load-displacement curve as shown in Fig. 5a. The dependency of CERR on mode angle is shown in Fig. 5b.

Discussion and Conclusion
In addition to the CERR measurements, the additional information about the delamination mechanism and e.g. process zone size provides extra parameters for improved modeling of the delamination (e.g. Cohesive zone modeling). Hence, the new miniature setup, capable of in-situ testing, is a significant development in delamination characterization of miniature structures.