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AN ADVANCED EXPERIMENTAL APPROACH FOR DETAILED \textit{IN-SITU} CHARACTERIZATION OF INTERFACE DELAMINATION

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ABSTRACT

System-In-Package (SIP) microsystems, contain several interfaces formed between stacked, multiple, thin layers, manufactured using different materials and processes. Interface delamination is often recognized as a critical failure mechanism concerning the reliability of these products due to the high stresses at the interfaces. Accurate measurement of interface fracture toughness/critical energy release rate (CERR) in these miniature interface systems over full range of mode mixities is an ongoing challenge. In addition, modeling of these interfaces requires good understanding of the underlying delamination mechanism which is far more difficult with existing macroscopic experimental setups.

In this research, a new miniature mixed mode bending (MMMB) setup for in-situ characterization of interface delamination is designed [1]. The schematic design of the loading mechanism to achieve mixed mode bending (MMB) loads over full range of mode mixities is shown in Fig.1. The capability and functionality of the initial design (Fig. 2a) was proven from tests conducted on custom made glue interface samples [2]. Nevertheless, several modifications were performed to the initial design, in order to enhance its range of applicability: by increasing its limits of (i) maximum load, (ii) maximum displacement, and to improve its ease-of-use by increasing its (iii) robustness. Figure 2 shows the design of the improved MMMB setup (Fig. 2b) mounted in micro-tensile stage and eventually in scanning electron microscope (SEM) chamber (Fig. 2c). Important changes in the new design include (Fig. 2): (i) introduction of new hinges (1,2), (ii) replacement of the critical hinges with elliptical hinges to have more rotation (3), (iii) optimization of hinge geometry and increased robustness (4), (iv) all hinges are loaded in tension (5), and (v) increased length of the MLM (6).

FIGURE 1. SCHEMATIC OF THE MMB SETUP. LOADING POSITIONS ARE SHOWN TO ACCESS DIFFERENT LOADING MODES FROM MODE I (DCB) TEST TO END NOTCH FLEXURE (ENF) TEST.
The setup was used to study copper lead frame – molding compound epoxy interface structures (Cu LF – MCE), which grabbed much attention from the research community as well as industry because of their wide applications and frequent failures during manufacturing and processing of these systems. Typical load displacement results from various experiments conducted at different mode mixities (Fig. 3) as well as in-situ measurements revealing the interface fracture mechanism (Fig. 4) during delamination will be discussed.

REFERENCES