In-situ Sensing of Interface Delamination in IC Packaging

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Research supported by Intel Corporation, Program Manager: Dr. Gaurang Choksi

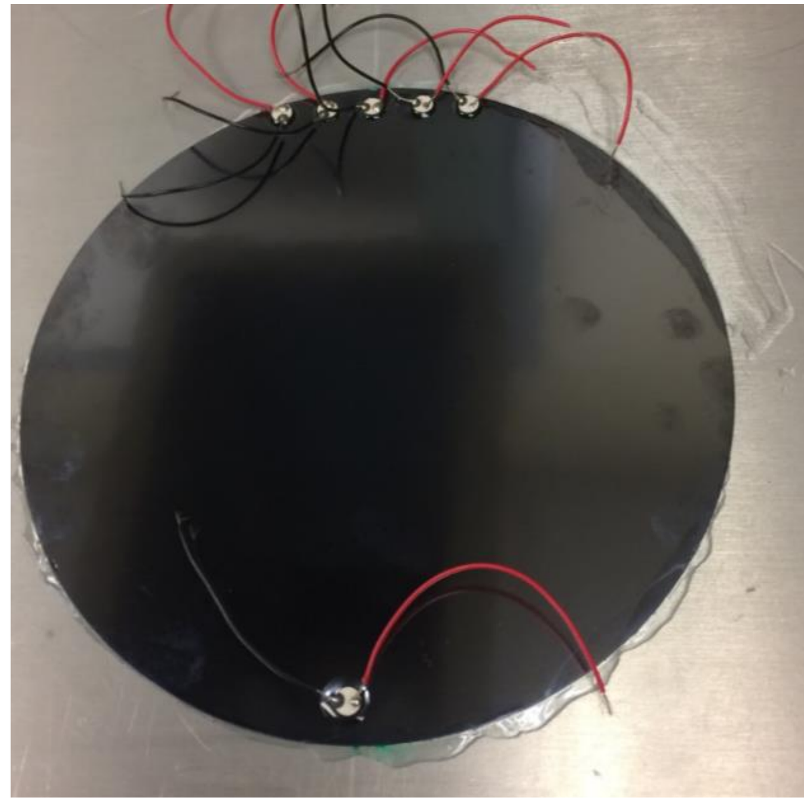
Objectives:

- **Detect pre-existing thermal interface material failure and sealant delamination in the heat sink region**
- **Develop stress sensitive CNT & CNF multifunctional membrane for spatial strain monitoring of IC packages**
- ***In-situ* sensing of delamination and prognosis modeling**

Proposed Approach

- Implement a novel guided wave approach to detect and quantify delamination at the Integrated heat sink interface.
- Enable resolution enhancement over Scanning acoustic microscopy.
- Enhance resolution by using Matching pursuit decomposition (MPD) and Time Frequency (TF) analysis.

Complex Laminate

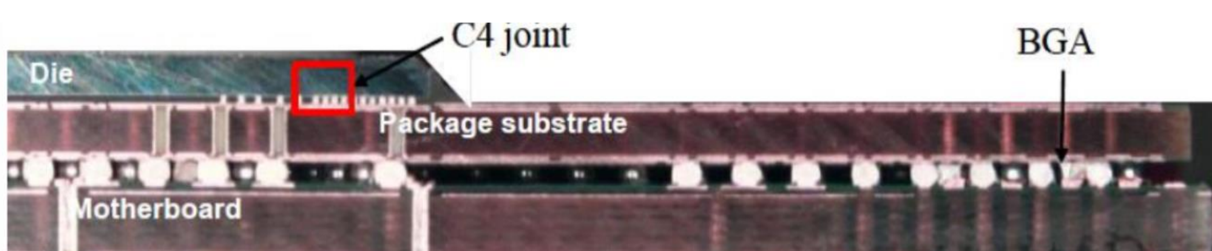


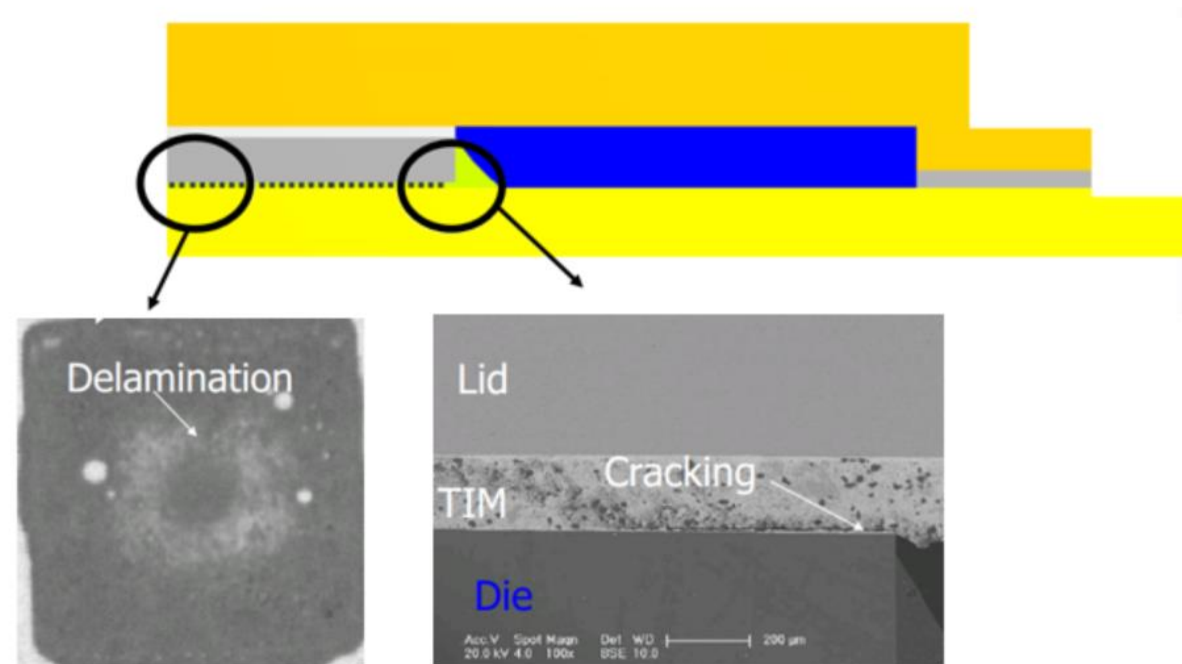
Fundamental Study on Guided Waves in IC Packages

- Study propagation of guided waves in Si-TIM-IHS interface.
- Cohesive zone modeling of interfaces by performing fracture tests (Mode 1 and 2).
- Material property characterization under loading conditions.

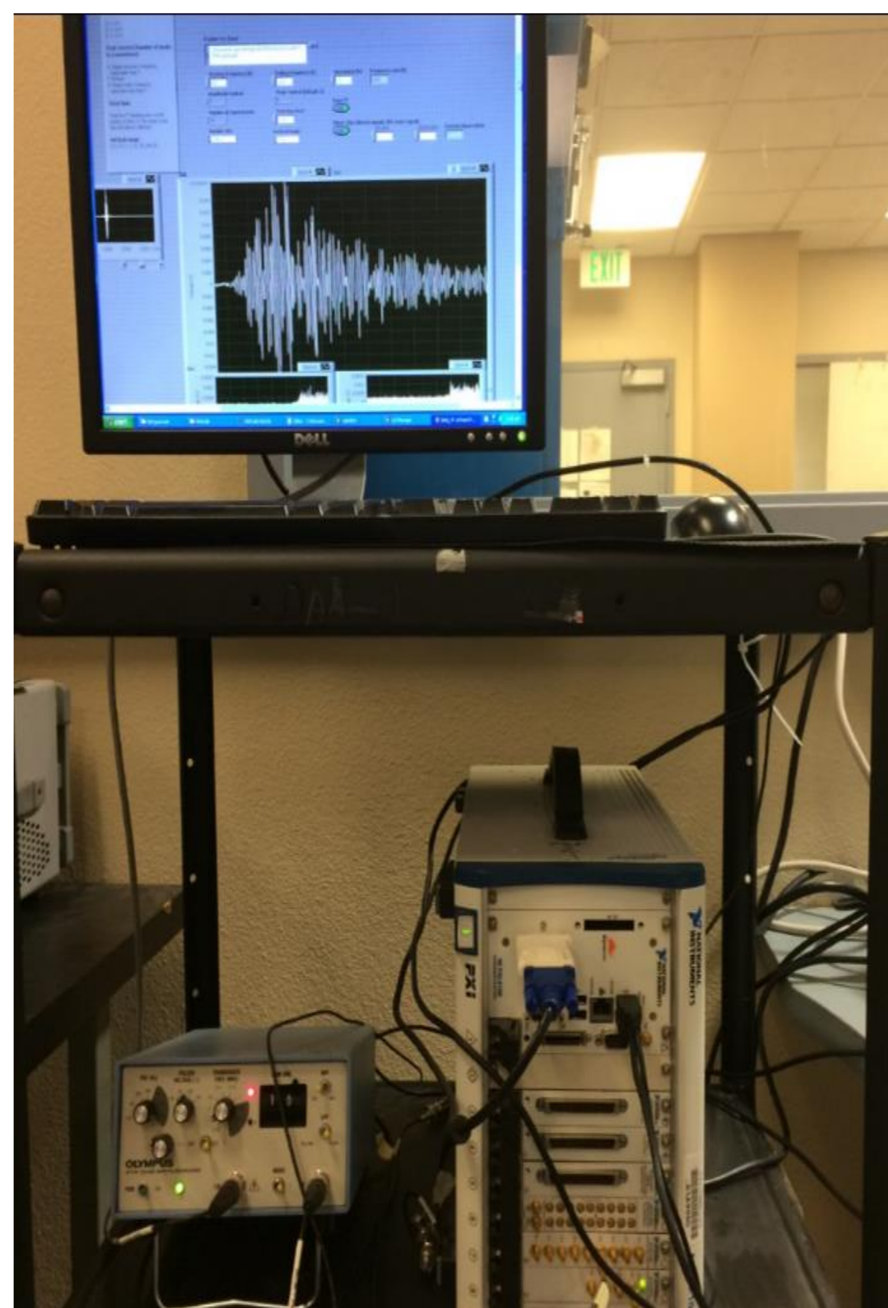
Problem Statement

- Delamination detection.
- Bond line thickness measurement.
- Interfaces:
  - IHS – PTIM / Si-PTIM
  - IHS – Sealant / SR-Sealant

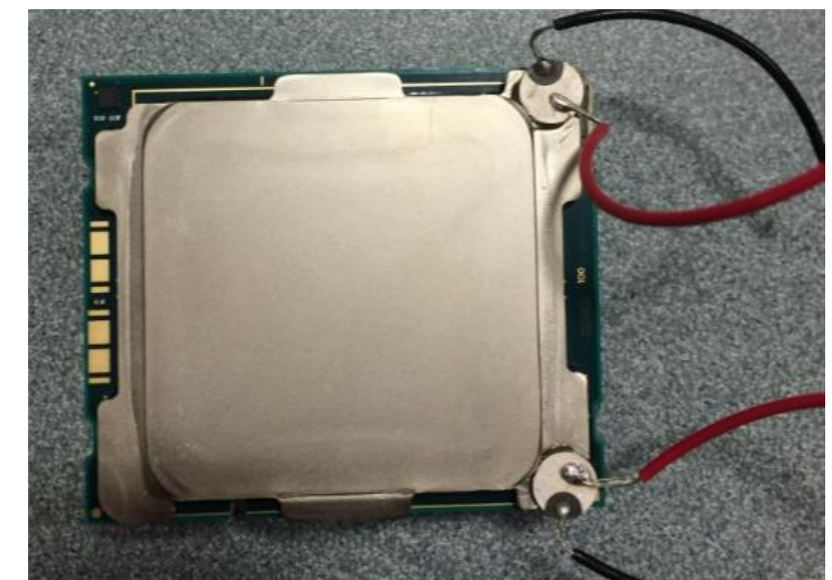


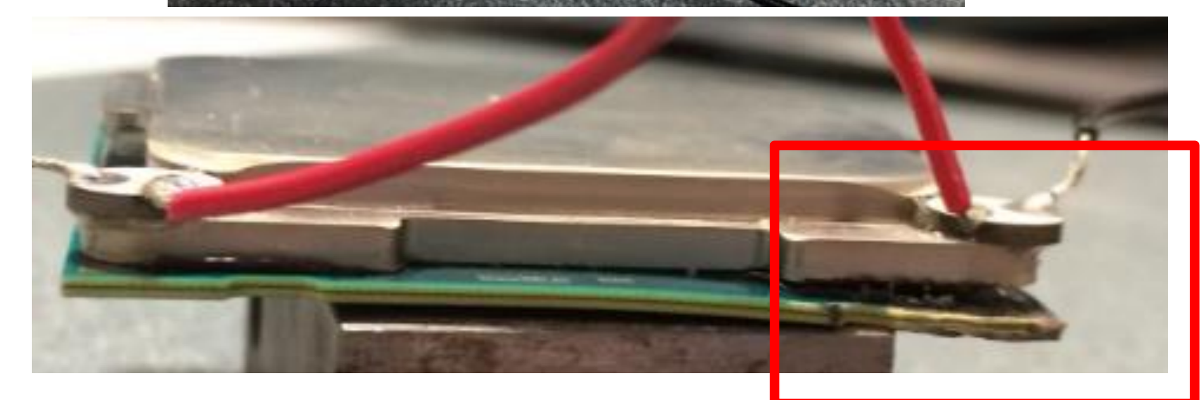


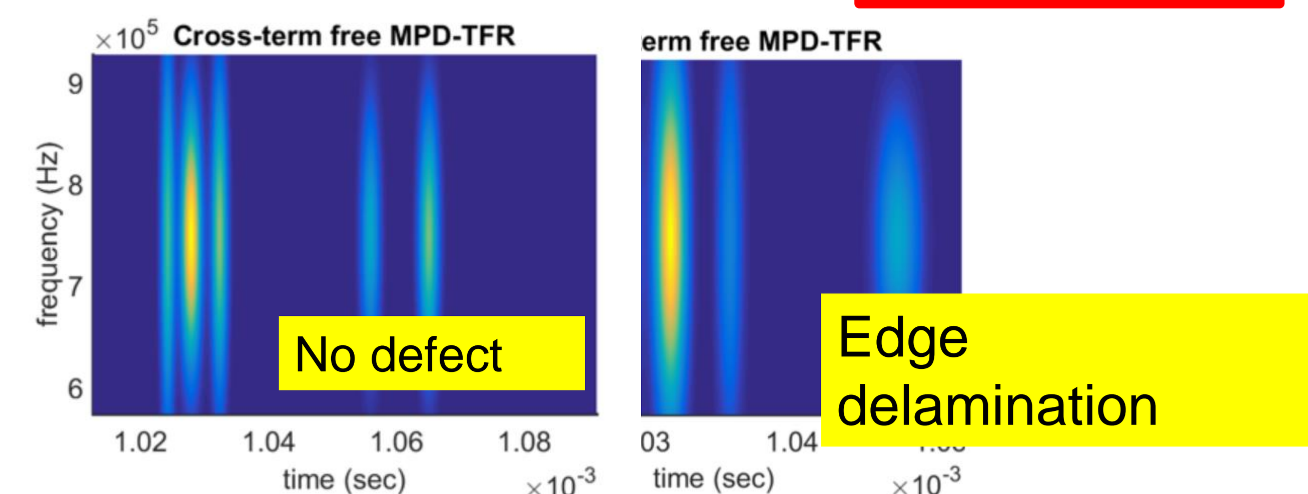
Guided Wave and Ultrasonic Testing Apparatus



Inspection of Intel Samples

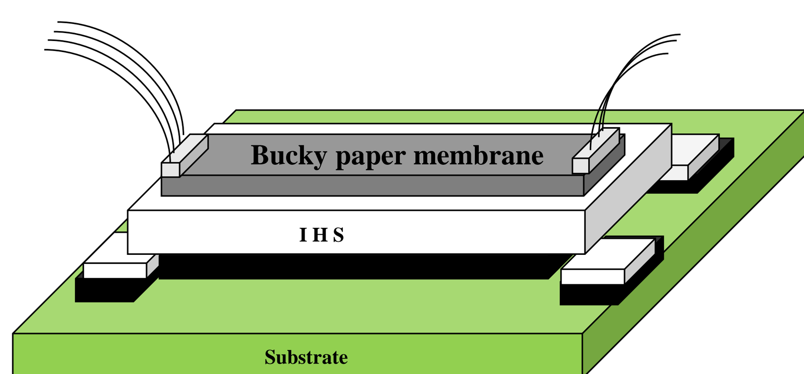






Objectives:-

- CNT nanocomposites with self sensing capability
- Process development for scalable fabrication of CNT buckypaper

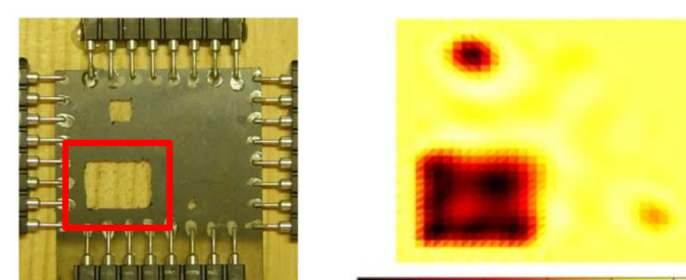


Bucky paper multifunctional membrane

Stress sensitive multifunctional membrane

Embedded Strain Sensing

- Develop CNT integration methods in IC Packages
- CNT nanocomposites with self sensing capability
- Process development for scalable fabrication of CNT buckypaper
- Accurate strain and crack quantification using *in-situ* electrical measurements



Bucky Paper TIM

- Better thermal properties than Thermal interface material*.

Table 4 – Thermal Performance comparison of various TIMs.

Product	Thermal impedance (K/W)	Enhancement
Dry contact	0.151	Reference
Aremco 640	0.071	52.98%
Shin-Etsu MicroSi® G751	0.098	35.10%
Dow Corning® TC-5121	0.096	36.42%
Omegatherm 201	0.081	46.36%
PowerFilm 51	0.474	−213.91%
Thermal Grease TIC-1000A	0.072	52.32%
HighFlow 565U	0.221	−46.36%
CNF-PS	0.833	−451.66%
CNF-LHT	0.723	−378.81%
CNF-HTT	0.069	54.30%

*Carbon nanofiber based buckypaper used as a thermal interface material. Lafdi Et Al.