



PAD CRATERING

THE INVISIBLE THREAT TO THE ELECTRONICS INDUSTRY

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What is Pad Cratering?

- IPC-9708
 - **1.2.4 Pad Cratering** “The formation of a cohesive (or adhesive) dielectric crack or fracture underneath the pad of a surface mount component, most commonly BGA packages.”

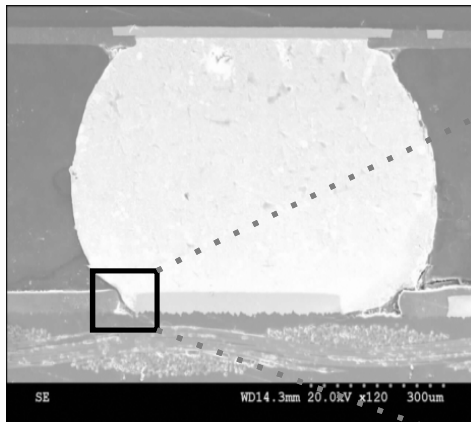


Figure 1

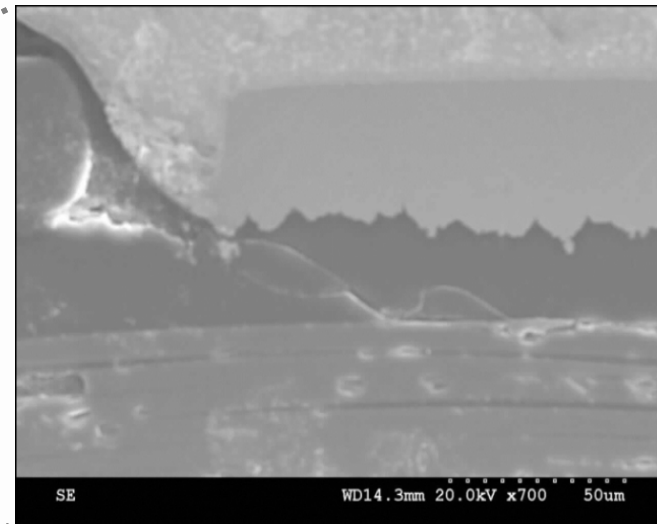
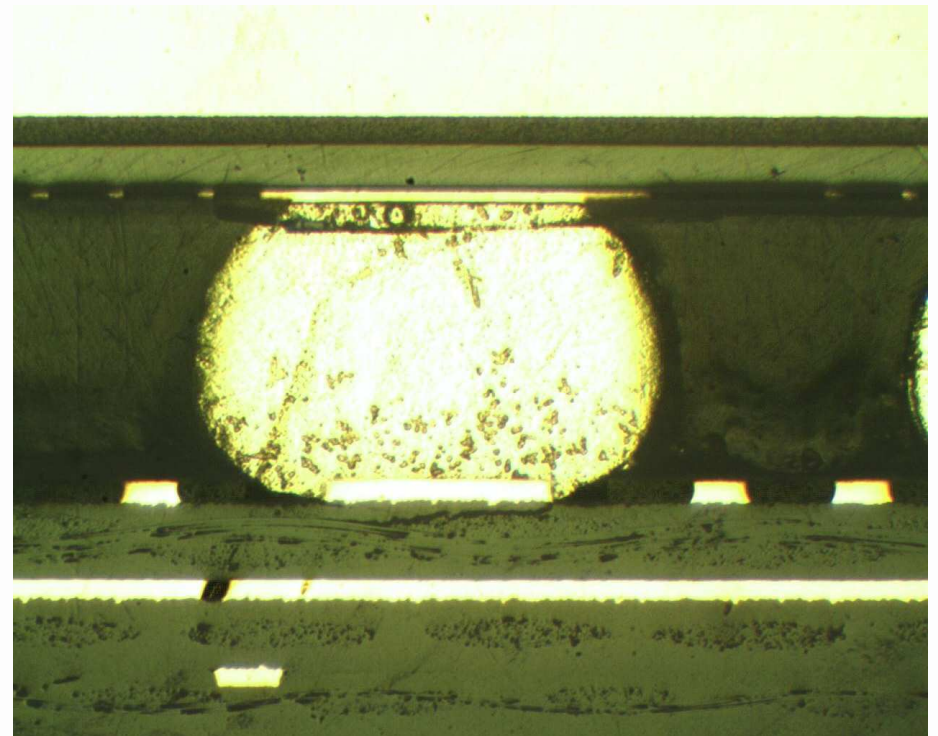
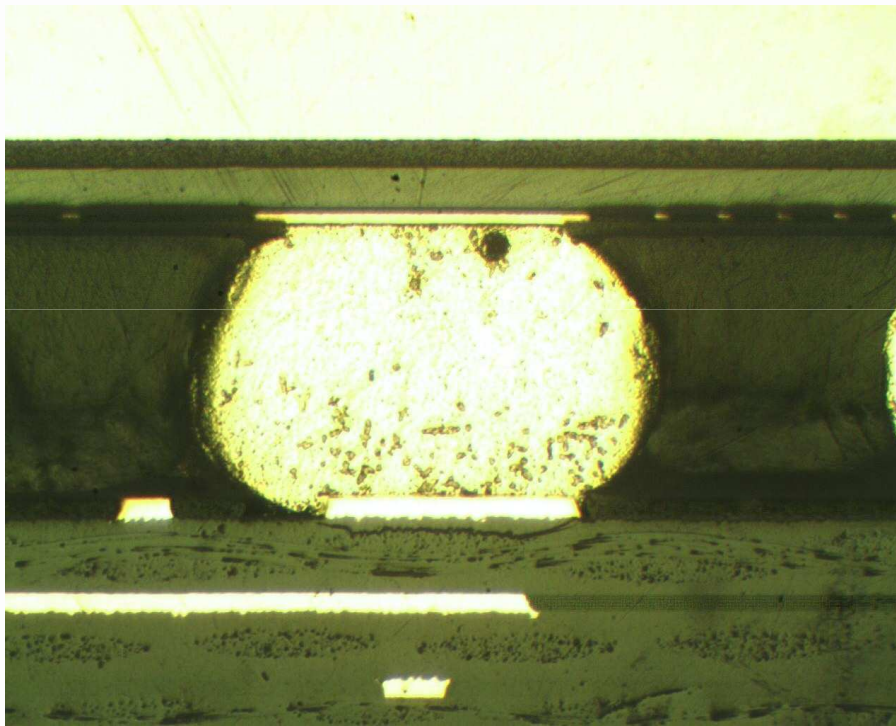
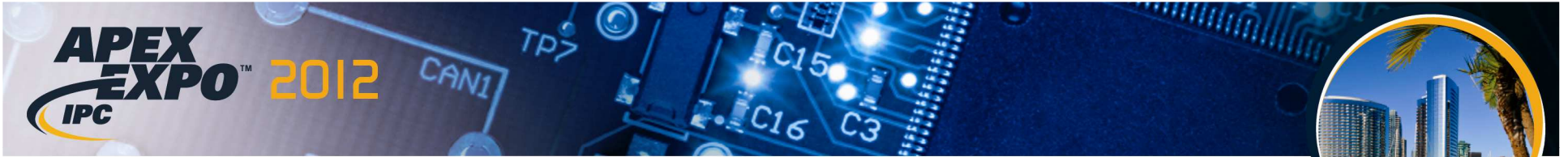


Figure 2

Pad Craters





Pad Cratering... Opens Circuits



- This occurs when the resin crack (fracture) migrates through a copper trace or via.
- This happens at assembly, in service or during handling.
- When component is removed, PCB copper pad comes with it, leaving behind a “crater” in the PCB.
- Has become more prevalent with lead free assemblies.
- Contributing factors include board thickness, size, resin type, CTE of the PCB and component, solder type, component position, assembly conditions post assembly handling.



How is the Electronics Industry dealing with this Defect Mode?

- Epoxy filets (mounds) at the corner of the BGAs,
- Increased pad or trace widths (Increase in pitch).
 - This is the only one to show improvement in practice.
- Change trace path.
- Increase PCB thickness.

These fixes are counter to the need to increase board density.



What does this have in common with a Pad Cratering solution?

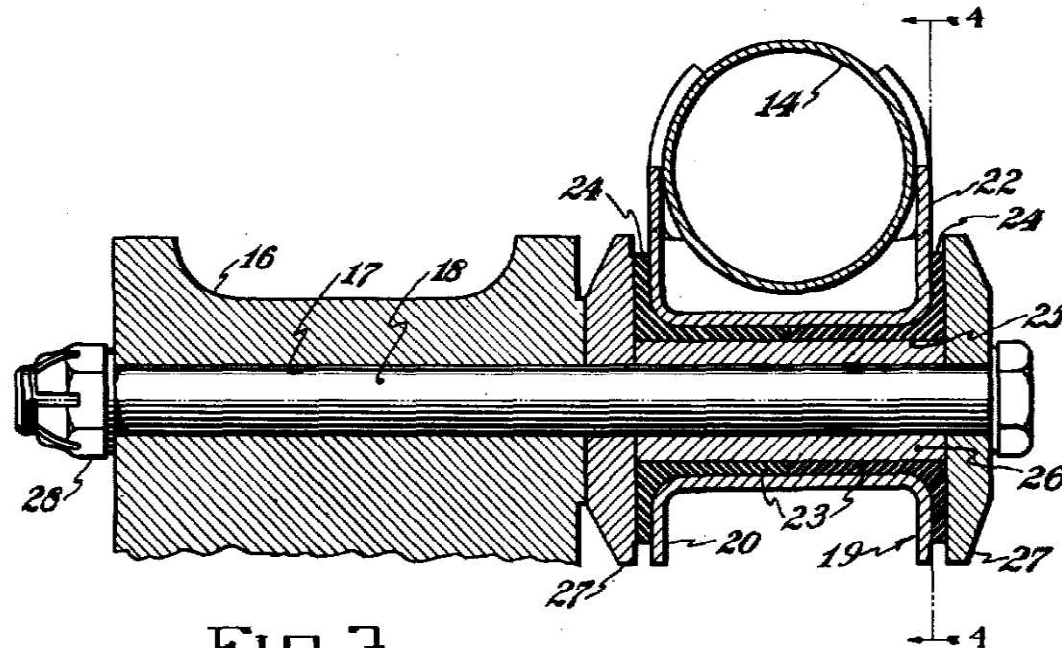
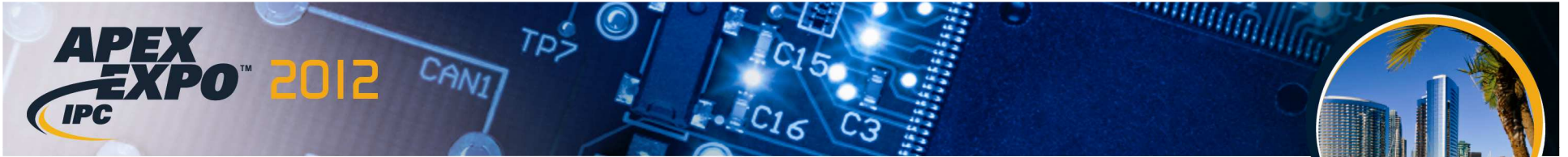


Fig. 3.

- Filed April 12, 1934 US Patent 2,109,329
- Aircraft engine mount with resilient (rubber) layer.
- Prevents fractures in frame from shock and vibration created by engine.



- **re·sil·ient**

- \ri-☐zil-yənt\
 - *adjective*

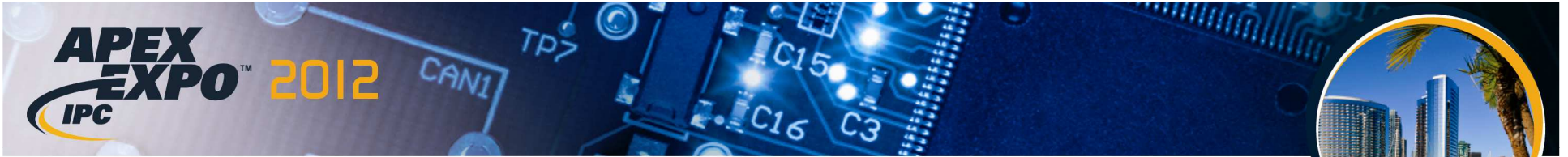
: characterized or marked by resilience: as

a : capable of withstanding shock without permanent deformation or rupture

b : tending to recover from or adjust easily to misfortune or change

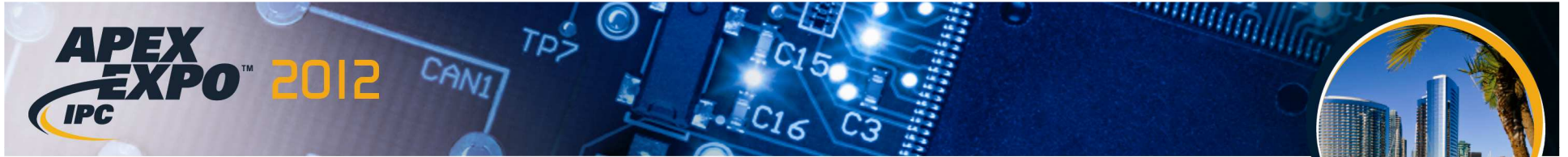
- **synonyms see elastic**

From Merriam-Webster



Material Properties that help resist Cratering

- Non-Brittle
- Medium Modulus
- High Tg
- CTE close to copper
- Must also be
 - Lead free solder compatible
 - Halogen free
 - Compatible with normal PCB processing



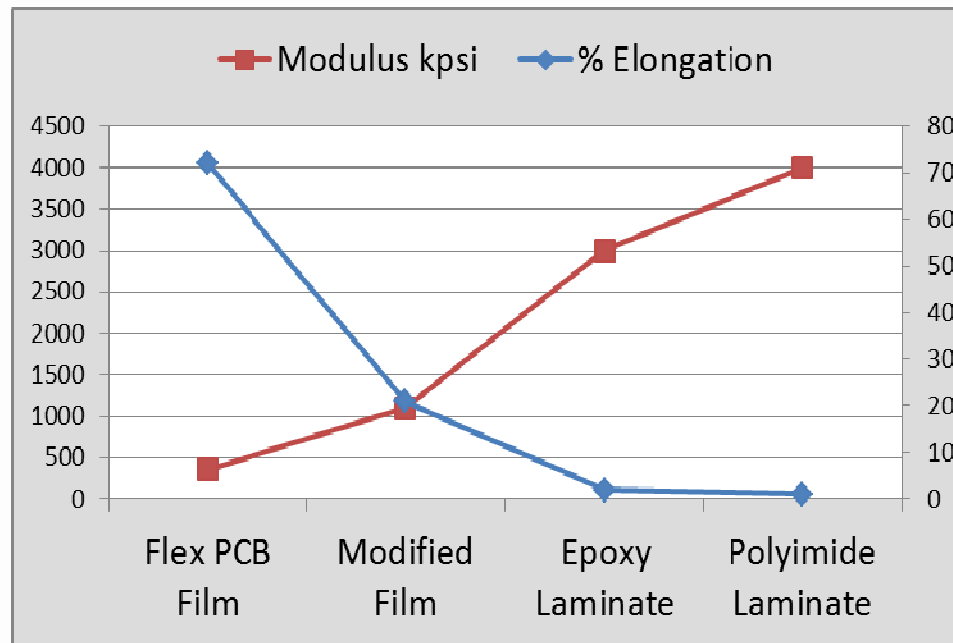
Film Based Materials

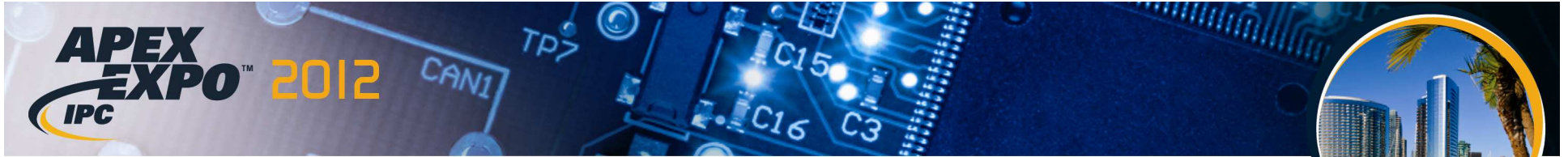
- Adding films in specific layers creates opportunities for unique structural benefits. Traditionally, this is done for;
 - Electrical properties
 - Rigid-flex
- Taking the cure process out of the PCB shop opens up the use of different materials.
- May be tailored to the following;
 - Low neat resin CTE while still remaining resilient
 - High Tg and Tg while being halogen free



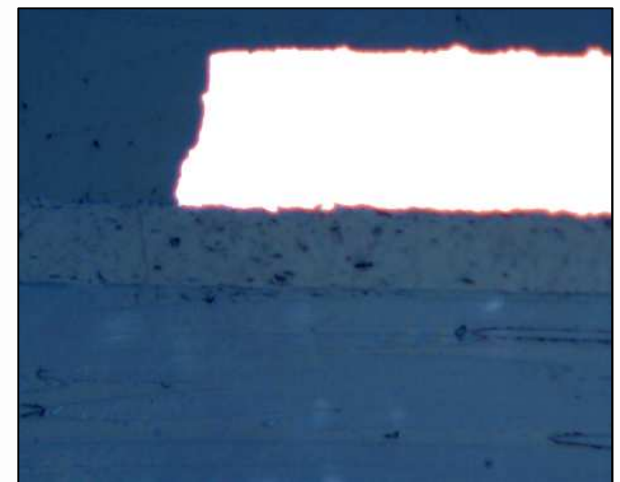
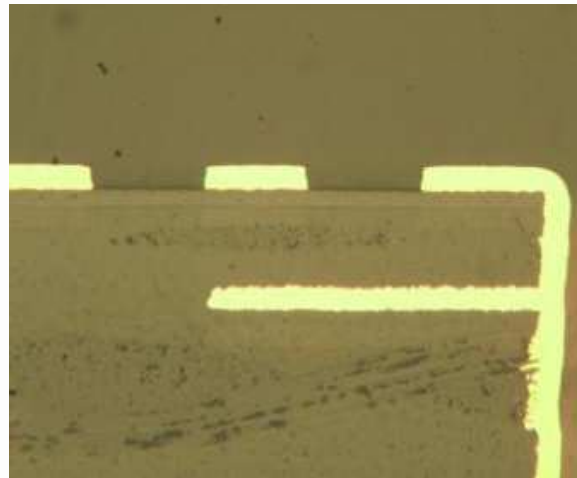
Material developments that are addressing Pad Cratering

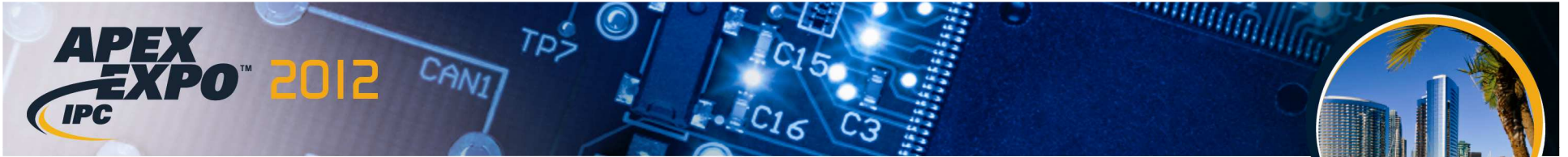
Higher modulus than flex material, yet more flexible than standard rigid materials (see below).



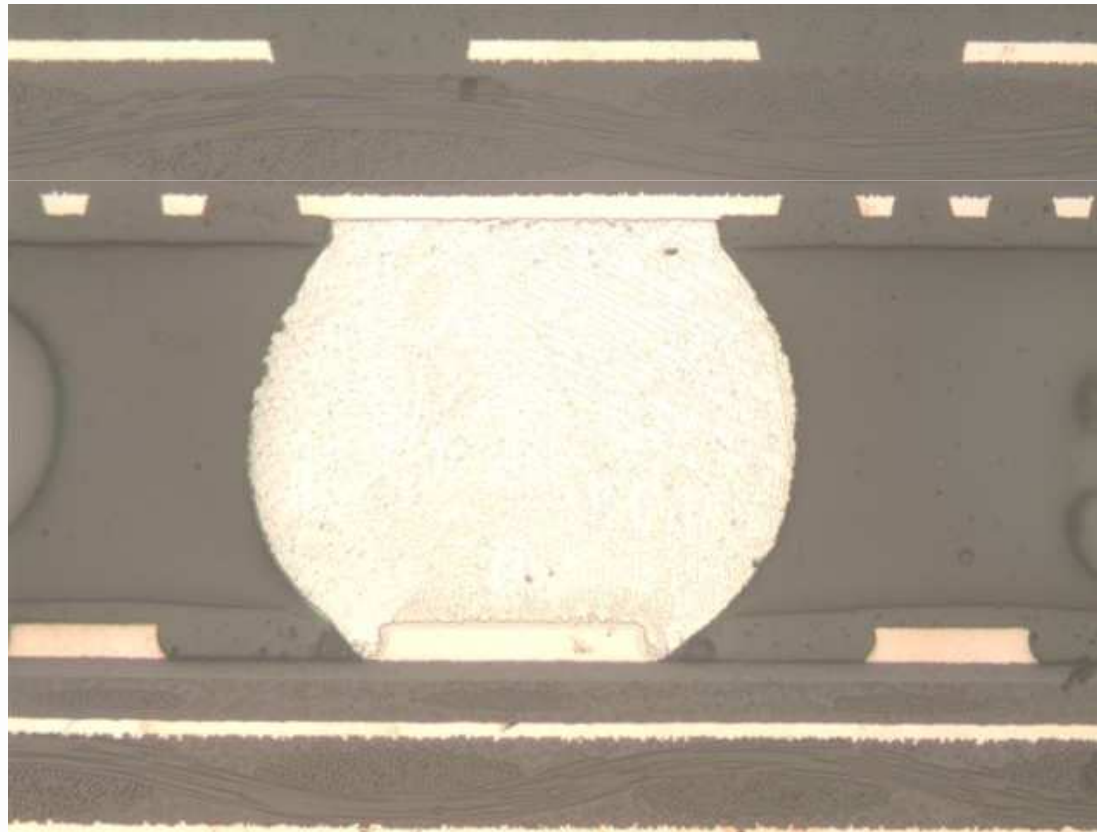


A pad crater resistant structure may be built using a fracture-resistant film on the surface layer. This resilient layer is in direct contact with the copper pad, preventing fractures from starting or reaching the copper trace or via.



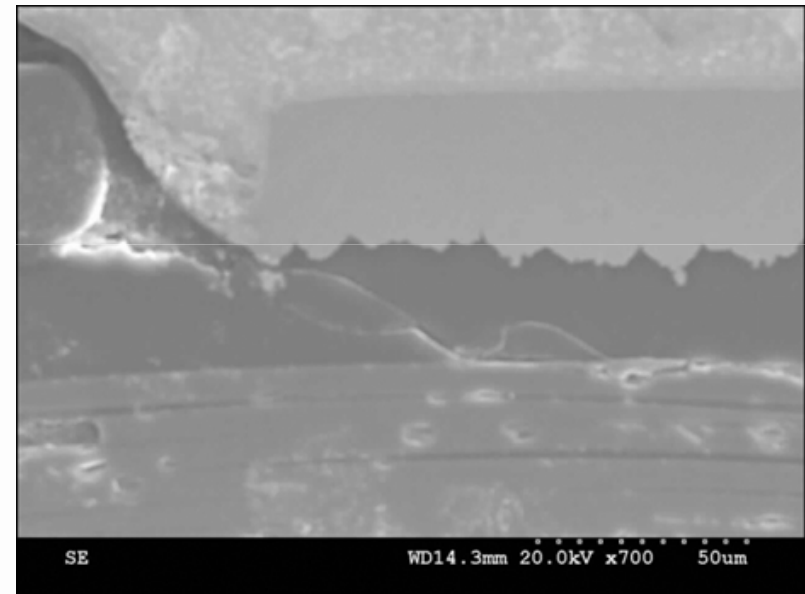
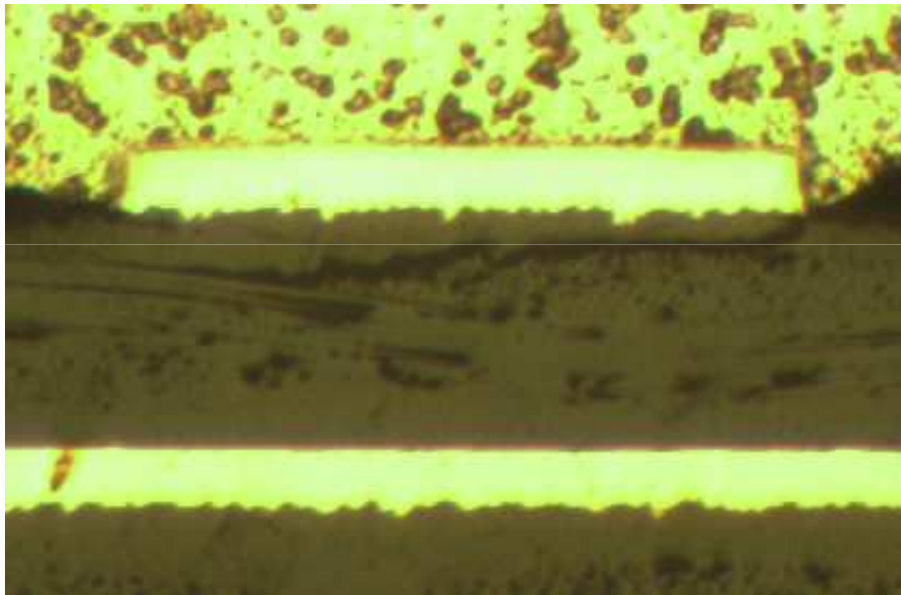


- When used as a cap layer (see below) it becomes the interface between the copper pad and the rest of the PCB.
- The more pliant cap will prevent or block fractures and protect copper connections (traces) to the pad.



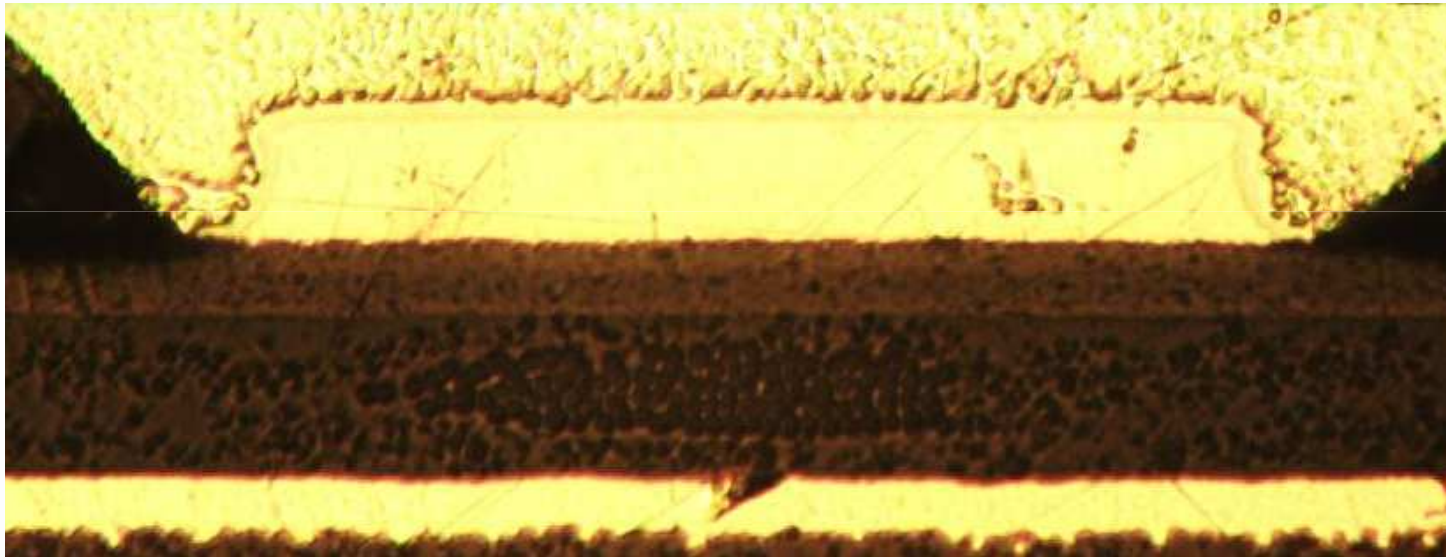


Examples of Fractures

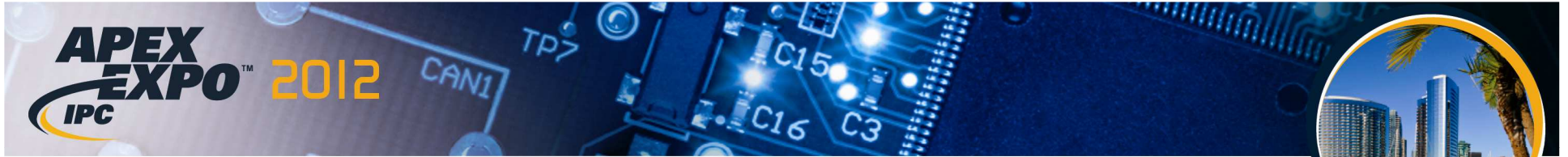




Fracture Barrier



*Courtesy: Murrietta Circuits, Inc.
Anaheim, CA*



As technology advances. . .

Pad Cratering will continue to challenge the industry.

Grater demand for density, reliability and signal performance, while complying with Lead free and halogen free increases the challenge.

Improved thermal performance often comes with lower flexibility.

High performance films used as a fracture barrier allowing current materials to perform better under mechanical stress.



Film based materials offer other benefits:

- Can be used alone or with more traditional glass based materials.
- Controlled Dielectric Spacing without fiberglass.
 - C stage/B stage combinations
- Better Breakdown Voltage performance.
- Improved transmission line performance (DK, Df) without glass reinforcement.
- Film based materials taken beyond flex for improved reliability, density and electrical performance.