

## Ormet Interface Materials Adhesion to Various Metal Surfaces

**Task Summary:** Determine adhesion of Ormet paste to different board surfaces, including bright copper, copper oxide replacement, and electroless nickel with immersion gold (ENIG). Use standard methods such as lap shear coupon per ASTM or other widely recognized method.

**Background:** Ormet interconnect materials for Z-axis interconnects in multilayer PWB's features metallurgical connections between the conductive compounds and metal copper layers. The strength and integrity of this bonded interface layer is key to the reliability of this interconnect technology. The boundary layers between copper and the Ormet conductive compounds are a complex metal system that develops during the multilayer product lamination conditions; therefore, all test samples and procedures much follow product conditions as closely as practical to yield meaningful test data.

In application, bright copper and adhesion-promoting finishes on copper are in common use. Both types of copper surfaces shall be tested. Electroless nickel/ immersion gold (ENIG), silver, hot air solder leveled (HASL) and organic solderability preservative (OSP) are outside layer finishes, without application to Ormet interconnects and therefore will not be tested.

Mechanical strength is a key indicator for interconnect robustness. A strength test was devised to determine the shear strength of a copper to conductive compound to copper test sample, including sample preparation techniques, time/temperature profiles for bonding, pull test apparatus, data recording and visual results. The tests follow industry standard tests as closely as possible.

**Purpose:** The purpose shall be to test the shear strength of a copper-to-conductive compound-to-copper interconnect using an industry standard test method.

**Scope:** The scope of the activities shall include Ormet interface compounds both lead-bearing and lead-free versions. Solder paste as a conductive compound shall also be tested for comparison purposes. Data collected shall be the total load to failure in pounds or force kilograms. Visual characteristics shall also be included with an emphasis on the interface between the copper and the conductive compound.

**Activities:** A standard test sample size was developed for ease of fabrication and also to have shear strength load high enough for behaved data. ASTM Method D5868-95 Standard Test Method for Lap Shear Adhesion of Fiber Reinforced Plastic (FPR) Bonding was used as a model for this testing. The Ormet to metal interface area was set at .50 inch by .25 inch. The bonding of the sample was performed at typical lamination times and temperature schedules. The lamination (bonding) schedule was as follows:



1. Lamination press set at 250F and stabilized.
2. Samples loaded into the press and pressure set at 200 psi.
3. Temperature changed to 370F
4. When temperature reached 370F, the temperature was reduced to 350F and held there for one hour.
5. After the one-hour soak, the lamination pressure was released and the samples were removed from the press. (The exception to this step is that the solder samples were cooled in the press and under pressure.)

Each sample was loaded into the holding fixture of an Instron testing instrument.

Each sample was loaded at the rate of 0.5 inch per minute until failure of the interface. The load at failure was recorded.

Alpha Prep is a trade name for a popular copper surface micro etch to promote adhesion to various prepregs.

Test results showed the following for Ormet 7001:

- |                         |                              |
|-------------------------|------------------------------|
| 1. Bright copper finish | ave 253 lbs (std dev 17 lbs) |
| 2. Alpha Prep           | ave 185 lbs (std dev 14 lbs) |

Test results showed the following for Ormet 700

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|-------------------------|------------------------------|
| 1. Bright copper finish | ave 163 lbs (std dev 23 lbs) |
| 2. Alpha Prep           | ave 143 lbs (std dev 25 lbs) |

Test results showed the following for solder paste

- |                         |                              |
|-------------------------|------------------------------|
| 1. Bright copper finish | ave 284 lbs (std dev 34 lbs) |
| 2. Alpha Prep           | ave 252 lbs (std dev 37 lbs) |

Conversion from pounds for these samples to pounds per square inch is as follows:  
Load at failure in pounds X 8= Pounds per Square Inch.

All material separations were through the solder and Ormet material. No failures were observed in the interfaces of the either solder-to-copper or Ormet-to-copper samples.

The bright copper samples show higher strengths than the Alpha Prep but none of the strengths or failure mode suggests problems with Z-axis interconnect using either of these copper finishes.

**Conclusion:** All samples show adherence and a robust bond to the metal. The shear failure was through the Ormet material in all cases.