Material Volume Reduction

Task Summary: This task measures the volumetric reduction of the Ormet paste during various drying cycles. Use dispensed dot compounds and visual measurements to assess volume before and after drying cycles.

Background: The volume shrinkage of the Ormet conductive compounds is seen during normal drying and laminating common to the normal processing. The amount of this shrinkage and its relationship to successful interconnect has been of interest because of the need to interconnect consistently. Furthermore, shrinkage does occur during the lamination step when the layers are mechanically pressed together, the adhesives cure, the electrical interconnects are made and the entire structure is bonded and interconnected together.

Purpose: The purpose of this task is to determine the amount of material shrinkage during the entire interconnect process.

Scope: Ormet material #7001 shall be measured in actual adhesive layers, drying cycles and laminating cycles. Additionally, test card shall be used to clarify the shrinkage behavior of the paste. Cross section measurements and top view measure shall also be made. Automatic Optical Inspection shall be investigated for inspection of paste filling of vias.

Activities: Standard Z-axis vias were drilled with a composite prepregs with Mylar covers and attached to copper laminates. The drilled via diameters in the pre-preg and mylar were 15 mils diameter. These drilled layers were tacked to a copper laminate creating a blind hole for filling. The filled vias were processed with customary lmethods.

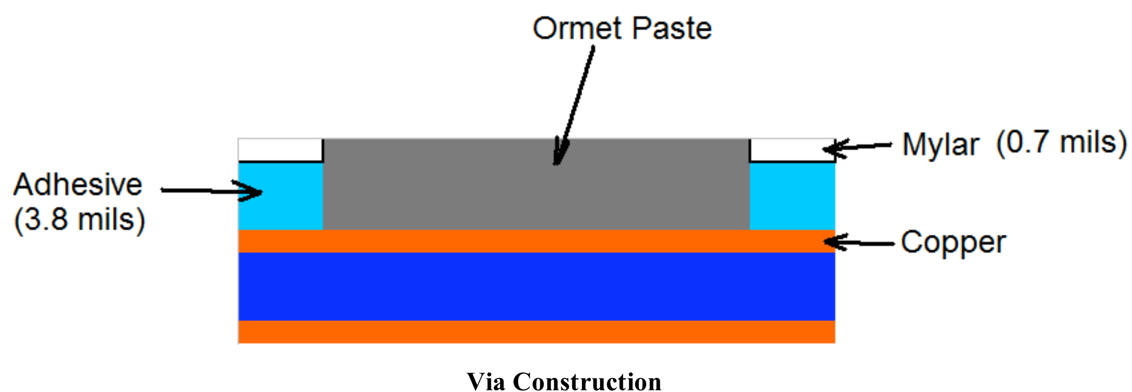
Drilled via diameters in the pre-preg and Mylar were 15 mils diameter. These drilled layers were tacked to a copper laminate creating a blind hole for filling. The filled vias were processed with the customary methods. Various measurements of the filled and dried vias were made and recorded. These measurements were made with a high power microscope and a Z-axis measurements system where an optical focus is made and the instrument is set to zero. A new focus is made and the distance is read directly from the measurement instrument. This instrument has the measurement accuracy of +/- 0.0001 inches.

The small features of common vias 15 mils in diameter makes precise and repeatable measurements of shrinkage extremely difficult. Therefore additional samples of blind holes in sharply defined epoxy materials were designed and tested, and created with photolithographic methods rather than mechanical drilling. These features were 1.5 mils deep and 40 mils in length and width. They were filled and precise measurements made along the edges and in the center of the feature both before and after drying. The samples

were filled, dried and measured using the techniques and processes normal to via fill. No reaction lamination was done with the larger features. Lamination reaction was done on the small vias filled in the adhesives.

Therefore, a combination of the drying shrinkage in the larger epoxy configuration and lamination shrinkage in the adhesive vias was used to make final conclusions about the overall shrinkage from fill to final lamination in a typical application for Z-axis interconnects.

Results: The paste height measurements of the filled and dried vias were attempted and the results inconclusive. The measurements were inconclusive for the height of the filled vias and the height after drying. With these results, a new test method was devised in order to determine the shrinkage of the paste with drying.



Via Construction

Shrinkage or changes in height was also measured during the lamination cycle. It is typical for the adhesive layer to reduce in height with resin flow and filling of the copper topography. This closing was measured. The results are as follows:

Adhesive layer thickness: 3.8 mils
Adhesive layer thickness after lamination: 3.2 mils
Percent change in thickness: 3.0-3.8/3.8= -21%

Conclusion: Measurement of shrinkage of the typical Z-axis vias proved problematic. The paste is strongly affected by surface effect of the paste. Consequently, exacting measurements of the paste height was inconclusive.

A large blind hole was filled and dried with more behaved measurements. The data table shows a clear difference in the fill and dry height alone the edges of the holes as compare with the center. The average percent change in height was -21% which is consistent with the use of diluents that are expelled during the drying steps.

The results also shows the effort of screening or moving a blade over the blind hole. Different blades affect this feature differently. Metal blades are recommending because

polymer blades will “scope” paste from the hole leaving less paste in these shallow blind holes.

The recommend production methods for processing these vias is to fill, dry and then fill a second time.   This method is recommended to minimize the effect of paste shrinkage and to fill all holes consistently.

Lamination also causes a reduction in height and is generally favorable to forming a dense and well bonded interconnect.