Ormet Circuits, Inc.

Recycling Ormet Paste

Task Summary: Determine the limitations of recycling used Ormet 7001 as a function of material properties.

Background: Ormet 7001 paste is generally applied by spreading over a surface and collecting the unused material with a squeegee or doctor blade. Generally, the spread-and-collect process is repeated many times. At the conclusion of a work session, the paste may be collected and deposited back into the original container. The surface over which the Ormet 7001 is spread is dependent on the application and may alter the characteristics of the paste.

It is also known that the viscosity of the Ormet 7001 paste changes at room temperature (~25°C) due to polymerization. It has been demonstrated (see Shelf and Work Life Study) that this polymerization does not adversely affect the electrical performance of the paste and that the change in viscosity could be remedied by the addition of solvent. It would be instructive to determine the extent of the change in viscosity over typical work periods.

Purpose: The purpose of this task is to determine how the Ormet 7001 is changed as a function of use and to determine whether the changes can reversed/compensated for so that the paste may be recycled.

Scope: The activities were designed to determine the chemical changes in the paste with time at room temperature, the physical and chemical changes in the paste after a long continuous-work period, the relative losses of solvent and total organics as a function of surface type, and how the paste responds to methods to restore it to its original condition.

Activities: In addition to the activities performed specifically for this task, the room temperature shelf life study is relevant to the objectives of this task. In that study Ormet 7001 paste was left out continuously in a room temperature environment for several weeks. Although the viscosity of the paste increased dramatically, the electrical performance of test cards produced with the paste was unaffected. Further, diluting the paste to its original consistency restored the aged paste to equivalent sintering behavior of fresh paste according to differential scanning calorimetry (DSC).

In this task, the paste was aged in a constant temperature water bath and the sampling interval was reduced to hours rather than days. The viscosity of the paste was measured at times representing shift breaks, end-of-shift, one day out, two days out and 5 days out. After two hours at 25°C the paste viscosity was unchanged so the bath temperature was increased to 35°C to represent worst-case-scenario shop conditions (the polymerization is a function of temperature). The final measurement at 5 days was taken at 25°C to directly compare with the starting value.

The second activity performed for this task was to spread Ormet 7001 paste over a variety of substrate materials to determine the effect of the substrate on the composition of the paste.

The viscosity of a sample of Ormet 7001 was measured in accordance with the TE spindle method of Task 8, and a thermogravimetric analysis (TGA) was performed. In the TGA test, the sample was ramped from 25°C to 300°C at a ramp rate of 1°C/minute. The total weight loss was noted at 100°C, 150°C, 200°C, 250°C and at 230°C, the boiling point of the solvent in Ormet 7001.

The Ormet 7001 was then divided equally into 4 containers. The contents of each container was spread onto a 1 square foot substrate, left to sit for one hour, and then collected back into the containers. The four substrates upon which the paste was spread were: bare copper, FR4, Mylar and a stainless steel 230 mesh screen. The viscosity of the recovered paste samples was measured and a TGA experiment was performed on each sample according to the conditions above.

Conclusion: According to the results of the short-term viscosity study, taken in conjunction with the results of Task 12, it appears that no viscosity adjustment to Ormet 7001 should be required over an eight-hour shift. The changes in viscosity observed over several days indicate that a shift-change viscosity check and adjustment would be prudent.

The two data points taken at 52 hours suggest that some microstructure is created in the paste when it is kept in a static state. Because the microstructure was easily disrupted with gentle stirring, it is likely either a sign of settling or an associative thickening effect. Therefore, in a manufacturing environment it would be important to monitor viscosity both at a consistent temperature and after a consistent rest period from mechanical work to obtain meaningful results.

The viscosity results for the spread-and-recover experiment were somewhat inconclusive. Regardless of which substrate the paste was spread upon, the change in viscosity was small. The results of the TGA analysis echo the ambiguity of the viscosity results. All of the spread-and-recovered samples demonstrate slightly lower solids content than the original sample. The effect, though slight, was most pronounced on the rough surfaces – FR4 and stainless steel mesh. A disproportionate loss of solvent relative to the other organic components was not observed.

The results obtained from the spread-and-recover test are counter to the reports of some users of the material. These users contend that the viscosity changes rapidly as the paste is spread and recovered. Perhaps the cumulative effects of the very slight changes observed in the experiment escalate rapidly with continuous use. More work is needed to determine whether the changes observed by the users are due to a mechanism like friction heating or to a mechanism such as disproportionate loss of components during recovery.