AREA Consortium

February 2013 Newsletter

Dear Members;

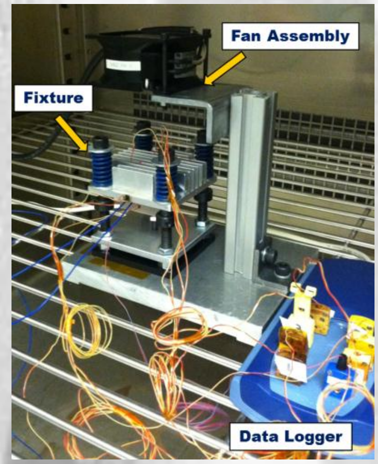
We had a very successful meeting in February with spirited discussions. Conversations were continued during coffee breaks, reception and dinner. From these discussions, we left the meeting with many new ideas for improving existing research and the possibility of adding new topics. At our meeting I was able to launch our new 2013 website that can be accessed by our Members and non-members alike. Research content is still protected and will require username and password access. The new website allows for new functionality such as content searching of the entire site. This will allow you to perform keyword searches accessing historic presentations, reports and proposals titles and included abstracts. This should make searching for historic data far less cumbersome. I intend to have all our historic data back to 1994 included on this site by the end of August. You can find our new site at https://sites.google.com/site/uicapl/.

As always, please let me know if you have any questions or concerns regarding my efforts or any of our research.

Martin Anselm, Manager AREA Consortium

TIM Update

We've begun characterizing gap pads on our component level TIM tester developed in 2012 (see image right). We'll compare the thermal performance of several different TIM pads as a function of bond line thickness and pressure. In March we plan to characterize gap pads at 10%, 30%, and 60% compression. In total we will characterize 15 different gap pads from 4 manufacturers. Six additional fixtures are being constructed for aging and thermal cycling experiments.



HMP

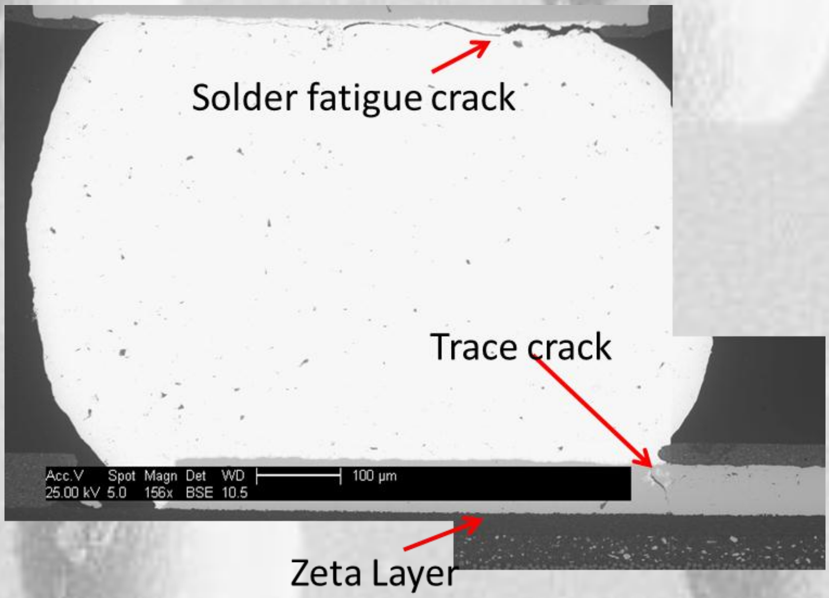
In February we completed the study of the effect of Sn-impurities on 92.5Pb-5Sn-2.5Ag. Through DSC experiments we found the liquidus temperature decreases roughly 3.7°C for every 1% Sn added, up to 7.4% added Sn. Additionally we found a substantial increase in the concentration of β-Sn and the growth kinetics of the Ni_3Sn_4 interfacial IMC with increasing Sn concentration. These results were presented at the February meeting.

In February we completed analysis of the Pb-free die shear testing results. The Bi-Ag-Xx alloys outperformed 92.5Pb-5Sn-2.5Ag after reflow and after liquid shock testing. Fractography of the liquid shock samples after die shear testing revealed two different deformed morphologies. Both Bi-Ag-Xx and 92.5Pb-5Sn-2.5Ag showed evidence of fatigue damage around the perimeter of the joint. However the joint interior for Bi-Ag-Xx showed a brittle step-wise fracture while 92.5Pb-5Sn-2.5Ag showed a cup-cone fracture indicative of ductile failure.

Pad Cratering

We have completed drop testing on our PCB Pad Cratering test vehicles (370HR laminate) which were 'prestressed' using a single spherical bend to 40 or 66% of the inflection strain (about 345 and 550 microstrain). The results indicate that the prestress processes reduced drop reliability significantly. Failure analysis is underway and we are preparing samples for cyclic bending and thermal cycling evaluations.

Additional ZetaCap studies have begun using the copper clad glass-free laminate over 370HR and Megtron 6 laminates. Solder ball level strength and fatigue tests have been performed in addition to assembly level 4-point cyclic bend tests. The bend test results indicate that the ZetaCap may prevent PCB pad cratering by shifting the failure from the circuit board laminate to the solder joint. However, PCB surface traces connected to the solder joint attachment pads are still susceptible to fracture –even when the ZetaCap is used. In the case of ZetaCap over Megtron 6 the surface trace failed at about the same time as the traces on standard Megtron 6, but the traces on ZetaCap over 370HR survived significantly longer than the traces over standard 370HR.

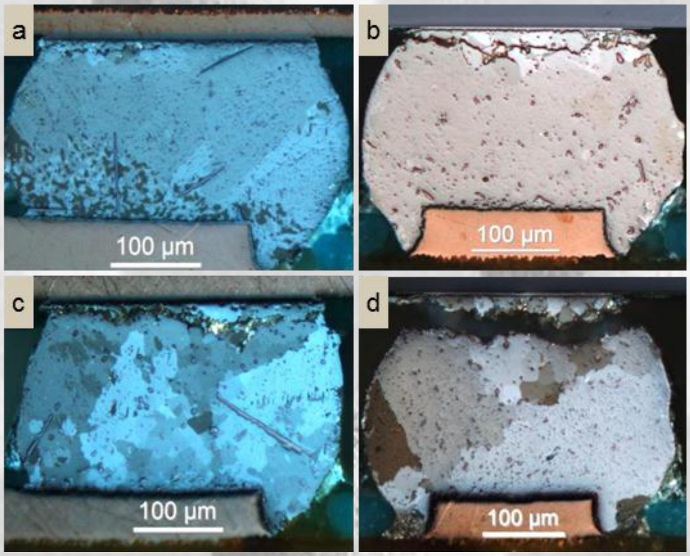


TB2013

We have made significant progress with our Test Board 2013 design which will be used for surface finish evaluations, underfill and conformal coat experiments, and solder microstructure studies. The bare boards have arrived and have been sent out for plating (ENIG, ENEPIG, SN100C HASL, ENTEK OM OSP, ENTEK PLUS HT OSP, and PallaGuard (direct palladium)). All components have been acquired and stencils have been ordered. We expect to have our initial build completed within three weeks, with plans to assemble entire test cells at member sites in early April and May.

LF Morphology Studies

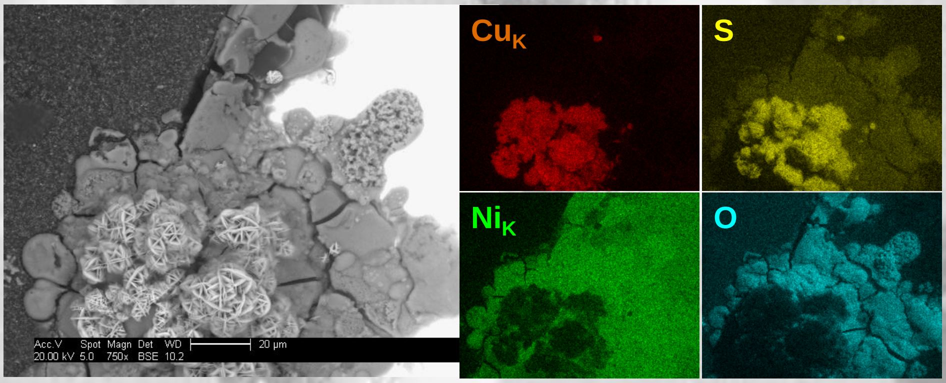
We have investigated the thermal cycling performance of solder joints in mild thermal cycling condition (20-80°C). Our results have showed that the failure mechanism in mild conditions is similar to harsh conditions (0-100 °C and -40-125°C). More work is needed to understand the recrystallization and effect of Sn grain morphology on reliability data. We are continuing our collaboration with HDPUG. In order to understand the failure in mild thermal cycling, we have planned to look at the samples at some intervals of life before failure. The 20-80°C thermal cycling test is currently being performed in Alcatel-Lucent.



Cross polarized images of CTBGA (a, c), CABGA (b, d). Samples a and b tested at 20-80°C while samples c and d were tested at 0-100°C test condition. In 0-100°C both samples have failed. However in 20-80°C CTBGA only shows partial cracking. In both test conditions recrystallization and intergranular crack propagation can be observed.

Creep Corrosion

The preliminary creep corrosion tests of ENEPIG substrates were concluded. Exposure to humid sulphur caused several types of corrosion, including some creep. The extent depended on the presence or not of chlorides, and varied among ENEPIG boards from different suppliers. In addition to the usual copper sulfide, the corrosion products included a distinct phase containing Ni, S, and O.



Effect of Thermal Cycling on Pad Strength

The experiment started in late 2011 and first discussed in March 2012 was concluded In February. After the parts that had been in cycling failed, they were removed from their board, their sites were reballed and the strength of the pads was measured with HBP. Non-cycled parts were treated the same way for comparison. The strength distributions of the pads from the cycled samples were quite lower than the distributions of pads in non-cycled samples, indicating that cycling had caused some damage to the pads.

Lead Free Folder Reliability Models

1) Thermal cycling. We have established a mechanistic understanding of damage evolution and what controls failure (usually recrystallization followed by intergranular crack growth). Testing and theoretical work is ongoing to formulate a quantitative model for the extrapolation of accelerated test results to life in service. So far this has allowed us to ascertain which solder joint configurations can be compared in accelerated thermal cycling, and which will give different acceleration factors and thus different life in service even if test performance is the same. It also appears to explain the superior performance of interlaced twinning structures (LGA vs. BGA) as well as suggesting that the relative benefit of these may even greater in service. The model does not apply to isothermal cycling, where life is controlled by transgranular crack growth. The question thus remains to which extent the model extends to the milder temperature excursions typical of long term service. So far, test results suggest that variations between room temperature and an operating temperature of 60C should be sufficient for recrystallization to control life.

2) Isothermal cycling. Testing of individual solder joints showed that the failure of a SnAgCu joint in isothermal cycling occurs after the accumulation of a certain amount of work. This amount of work does not vary significantly with cycling rate, dwells, or temperature (between RT and 100C, at least). It varies slowly with amplitude. It is essentially the same for 4 SnAgCu type alloys (SAC305, SAC105, SACX-plus and SAC(Ni). It is quite different for MaxRel. A preliminary comparison of the alloys in isothermal cycling at high strain rates suggests the differences indicated in the attached figure.