AREA Consortium

Dear Members,

It's been a busy couple of months. With two major events in September and October (AREA meeting and SMTAi) the staff and I have been at the breaking point. Despite those events we delivered our 2014 Research Plan which has several new projects defined. I must thank our Steering Committee that held its first meeting in early October. They answered some critical questions I had on several projects that needed clarification for the 2014 Plan. One new proposal, where we plan on evaluating the new JEDEC drop test board design, is already on the website (see REL10A below). We are focusing much our effort at the end of this year on new 2014 test board designs. A call for HDI description and participation went out earlier in the month and we have been receiving some great feedback from our members that will help us to add definition and design requirements to the HDI test board. The next two months promise to be especially exciting and our Holiday edition of our newsletter should be full of new reports and proposals for our members to catch up on!

Martin Anselm, Manager AREA Consortium

REL10A: Drop Test Proposal

We have received our allotment of test boards which will be used for evaluating the revised JEDEC drop test standard. The boards contain footprints with 100% via-in-pad connections, footprints with surface routing, and footprints to compare the effects of solder mask defined corner pads versus non-solder mask defined corner pads. In addition to the new boards, we also have samples designed to the current standard for comparison. We hope to build some samples in early November so that we can begin characterizing the response of the boards during drop testing at different drop table input pulses.

MAT8A: Conformal Coating

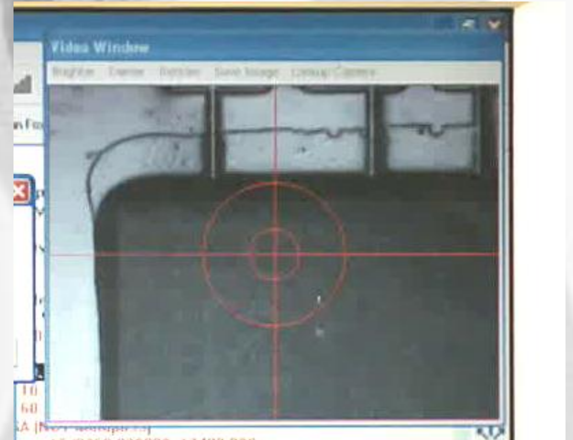
Cycling of the conformal coating samples from -40 to 125°C continues. The samples have now been subjected to over 1000 cycles and many failures have been recorded. Of our six test cells, one of the urethane materials applied at a thickness of 25 microns appears to be the most promising. However, it will take several more weeks before we will have sufficient data to compare these materials to our baseline data.

ADP3A: Advanced Packaging Considerations, TB2013

-55 to 125ºC thermal cycling of our Test Board 2013 assemblies continues. We have surpassed 725 cycles and have amassed many failures on the five surface finishes under evaluation. We have also noticed that many of the devices in test seem to behave differently (for lack of a better term) than they did during -40 to 125ºC thermal cycling. It will be interesting to see if our failure analysis reveals why such differences exists.

advanced process lab

MAT1A: Underfill Studies



All 4 materials in the test matrix have been acquired. All the boards for the thermal cycling tests have been assembled, and the first group has been underfilled and sent to ATC. Currently tests are underway with the second material. A technique has been developed to video record at high magnification the entrance and exit regions of the part being underfilled as the material flows and use the video for later analysis of flow times. To study the flow of the underfill and the interaction of the material with flux residues, two apparatuses have been developed and are in the final stages of testing. The first is used to make the samples, consisting of reflowed paste deposits between two glass slides, and the second to dispense underfill and observe and record its flow. The paste deposits are stencil printed and play 4 roles simultaneously: They are spacers keeping a uniform gap between the slides, they are "adhesives" keeping the slides together, they simulate the joints of a real part, and they act as a source of flux residues.

Peter Borgesen attended the 24th European Symposium on Reliability of Electronic Devices, Failure Physics and Analysis in Arcachon, France, presenting an overview of our work on "Solder joint reliability under realistic service conditions" and participating actively in workshops on the same topic. Companies attending and presenting included Toyota, Intel, IBM, Global Foundries, Toshiba, Flextronics, Hitachi, Skyworks, and European branches of ST Microelectronics, Freescale, Fuji Electric, Semikron, GE Healthcare, Thales, ABB, Fairchild, Siemens, NXP Semiconductors, United Monolithic Semiconductors, SELEX Electronic Systems, Spintec, Crocus Technology, 3S Photonics, OSRAM, Nanium, Infineon, Hella Fahrzeugkomponenten, EADS, and Huawei.

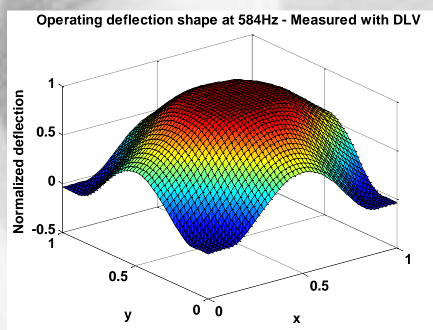
As far as solder joint reliability, pad cratering, etc, was concerned, there was a lot of interest in the type of research done by the AREA consortium, although the emphasis of European industry is much more on automotive and power electronics applications.

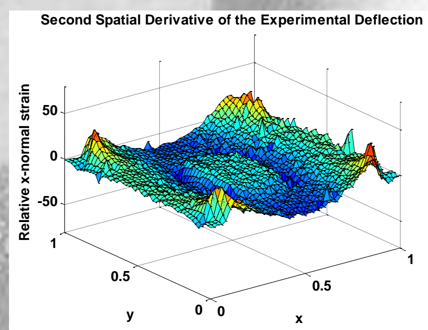
REL2A: Isothermal Fatigue of Solder

Studies of the effects of varying the cycling amplitude are ongoing. In general, the life is reduced (sometimes by orders of magnitude) compared to predictions based on Miner's rule. This sensitivity is weaker for SnAgCu alloys with less Ag. Consistently with this, aging for 1-2 years also tends to reduce the sensitivity, partially making up for an overall reduction in fatigue life at fixed amplitude. However, preliminary results now suggest that aging at 100-125ºC may lead to a strong increase in sensitivity. This is under further investigation.

REL3A: Vibration testing

A scanning laser vibrometer can measure the deflection of a circuit board at points on its surface while the board is subjected to vibration. Using this deflection, the surface strain field due to bending can be approximated by taking the second spatial derivative of deflection. The plot below on the left is the measured relative displacement for a three-inch square circuit board with a one-inch square component mounted at its center (x and y coordinates positions are normalized to board size). The plot at the lower right is the second spatial derivative of the displacement field in the x-direction, which is proportional to the x-direction normal strain at the surface of the board. As seen in this plot, high frequency noise in the data set is amplified with differentiation. We are looking at ways to alleviate the noise by using data smoothing filters. Knowing the strain field is useful for identifying optimal strain gauge mounting locations on the assembly for vibration and shock reliability testing.





MAT4A: TIM, Component Level Gap-Pad Characterization

During the September AREA Consortium meeting we presented the latest results from our gap pad comparison study. Thermal storage at 125°C for 1000hrs was shown to have little to no effect on the measured thermal resistance. Results were also presented on the mechanical behavior of TIMs during aging. The silicone putty and graphite layered TIMs experienced much more time dependent plasticity and stress relaxation than the silicone elastomer TIMs. Accelerated thermal cycling -40ºC to 125ºC for 1000 cycles at 30% compression is currently underway.

MAT6B: Die Attach and New LF Alloys

We are actively expanding our research on Pb-free die attach materials. With expiring Restriction of Hazardous Substances (RoHS) exemptions, it is now imperative to consider Pb-free alternatives for high temperature applications. We plan to evaluate a variety of materials, from at least four manufacturers, including Bi-based alloys, sintered pastes, metal filled epoxies, and new alloys developed by Binghamton University. Materials will be evaluated in terms of microstructure, strength, reliability, and thermal conductivity. During the summer of 2013 we developed a process for creating our own metallized die test vehicles at Binghamton University, which gives us more flexibility in testing.

MAT7A: New Lead-Free Solder Alloy Evaluations & Microstructure

We are continuing our effort to understand the reliability and failure mechanism of various new solder alloys in ATC test. We observed many similarities in the failure mechanisms of a number of different Pb-free SAC 305 solder joints (BGA, CSP, QFN, ceramic oscillators) which were subjected to either a mild or harsh thermal cycling test. Recrystallization was observed in these samples followed by crack initiation and propagation between newly formed Sn grains. Relatively long lifetimes were observed for samples which initially displayed an interlaced Sn grain morphology, as opposed to a beach ball Sn grain morphology. Examination of samples at 25% of their projected average lifetimes revealed that in samples with interlaced Sn grain morphologies crack propagation had not yet begun, although evidence of prolific recrystallization was revealed. We are currently trying to understand the reliability of other lead free solder alloys in various sphere sizes (10, 16, 20 & 30 mil) and compare them to SAC 305 and SnPb alloys. More than 300 boards were built using SAC 305, SnPb, SAC-Mn, SN100C ,SN99CN and SAC 305 mixed with Pb. Samples were reflowed on three different surface finishes (Cu/OSP, ENIG, ENEPIG). The thermal cycling test (-40 to 125ºC) will start soon.

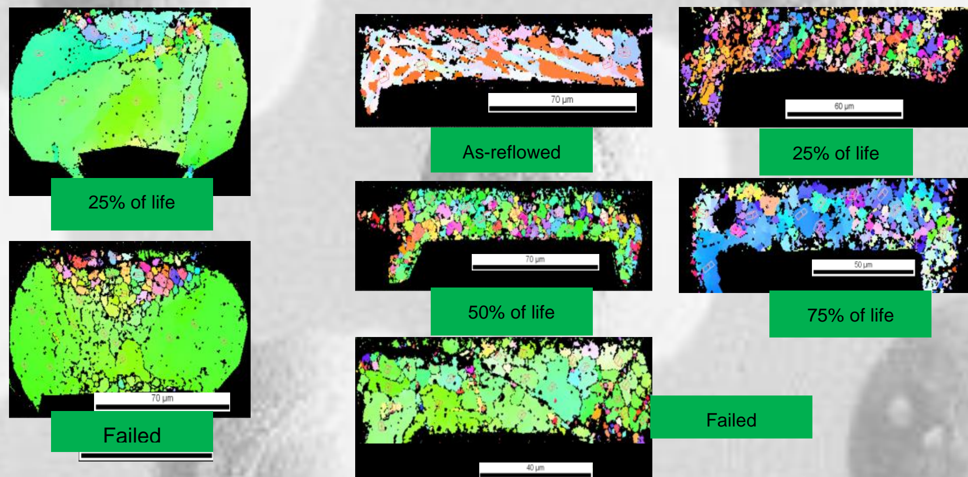
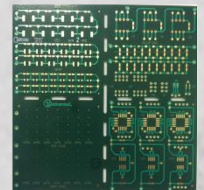


Figure shows the EBSD map of 10 mil SAC305 joints of LGAs and BGAs. LGA samples were taken out of the chamber at 25%, 50%, 75% and 100% of their projected characteristic life. BGA samples were characterized after 25% and 100% of their characteristic life.

High Temperature Electronics Research



We received the test board pictured at right the end of September. The first planned study for this board is joint level mechanical testing of various high temperature solder alloys. Both shear and fatigue tests will be performed on individual solder joints on our Dage 4000 and 4000+ systems. Initial comparisons will be made at room temperature. Then in-situ high temperature mechanical tests will be performed using a heated stage on the 4000+ system. Additional studies including ATC of surface mount thick film resistors, development of hand soldering process for surface mount and through hole components, and peel testing of Cu on polyimide will begin shortly.