AREA Consortium

December 2013 Newsletter

Dear Members,

What a year! I want to start this Newsletter by saying THANK YOU to all our members. It has been a very productive year with numerous significant advancements in our research and organization. This year also marks the founding of our Steering Committee that has been instrumental with assisting me with 2014 planning. I hope to continue to develop the Steering Committee and use them in assisting me improve our wonderful organization.

Our HDI design is under development so if any of our members wish to participate I recommend you contact Michael Meilunas (meilunas@uic.com) as soon as possible.

We here at the AREA Consortium wish you and your families a very Happy New Year and Happy Holidays. I'm sure 2014 will prove to be more successful than 2013!

Martin Anselm, Manager AREA Consortium

WEBSITE UPDATES:

- New Proposals on HMP alloys (MAT6C), Drop Testing (REL10A) and Compression of BGA solder joints (REL11A) http://www.uic-apl.com/Research-Plans/Research-Proposals
- List of our Members http://www.uic-apl.com/area-consortium/our-members
- Steering Committee Listing http://www.uic-apl.com/area-consortium/area-steering-committee
- Our Students http://www.uic-apl.com/student-development
  - Gil is graduating and we have his resume for download!
- New Reports http://www.uic-apl.com/reports/2013-reports
  - #1153 "On the Inapplicability of Current Models to Thermal Cycling Induced Fatigue of SnAgCu Solder Joints"
  - #1154 "Fatigue Life of SnAgCu Solder Joints under Realistic Service Conditions"
  - #1155 "PCB Laminate Evaluation: IT150DA, IT200LK and EM828"
  - #1156 "Effects of Thermal Cycling Parameters on the Life of SnAgCu Solder Joints"
- September On-Demand Presentations and Partnership Aware Winner Images http://www.uic-apl.com/meetings/2013-meetings
- Test board designs for Vibration and Spherical Bend Testing http://www.uic-apl.com/board-designs
- PoP processing videos http://www.uic-apl.com/process-support
- 2014 February and June Meeting Dates http://www.uic-apl.com/

ADP3A: Advanced Packaging Considerations, TB2013

-55 to 125°C thermal cycling of our Pb-free Test Board 2013 assemblies continues. We are approaching 2000 cycles and have amassed many failures on the five surface finishes (Cu OSP, Ag OSP, ENIG, ENEPIG, Pd) that are being evaluated. Cycling should be completed in early January and failure analysis should be completed soon thereafter. Similar samples, already subjected to -40 to 125°C thermal cycling, are currently being analyzed as well

advanced process lab

REL10A: Drop Test Proposal

We continue to evaluate the newly proposed JEDEC drop test board. Samples of the newly proposed board as well as samples of the current standard have been assembled and a strain characterization for 1500 to 2900G drop pulses has been performed. Right now we are awaiting additional input from the JEDEC committee to determine the next step in our analysis.

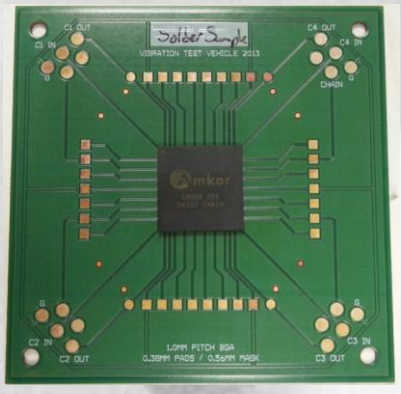
MAT8A: Conformal Coating

The first phase of our conformal coating program is nearly completed. The samples were subjected to over 1500 cycles and many failures have been cut from the test boards and analyzed in cross section. Expect an update at the next consortium meeting.

Our next conformal coating analysis is already underway. We have assembled several BGA, CSP and QFN devices to our "Phoenix" test boards using a SnPb process. The boards have been shipped out for cleaning and conformal coating and are expected to be in the thermal cycling chambers by mid-January. The test board design and project proposal can be found on our website.

REL3A: Vibration Testing

We received the new vibration test vehicle (VTV) for 2014. The board is a six layer design using 370HR. New features include 45 degree input traces to the corner joints and full area array CABGA 256. Another added feature is the trace routing on the corner joints. These boards have been designed to isolate failures at the corner joints in mechanical testing. Test assemblies built so far have been configured with two solder materials SAC105 and SnPb37 along with two package types LGA and BGA. Currently these boards are being modeled, used for vibration testing characterization and drop testing experiments.



MAT4A: TIM, Component Level Gap-Pad Characterization

The study "Component level Characterization of Gap Pads" will be completed in early 2014. Thus far we have characterized the microstructure and thermal performance of 14 commercially available gap pads as a function of compression. Also we measured the thermal resistance of each gap pad after thermal storage at 125°C for 1000hrs at 30% compression. Results from these experiments can be found on the consortium website. Accelerated thermal cycling of the test vehicles has been underway since September 2013. We plan to report the results of the ATC test during the February AREA Consortium meeting. We are planning to characterize phase change TIMs using the same test vehicle. Testing is planned to start in January.

MAT7C: Effect of Precipitate Size and Spacing on Thermal Fatigue Performance of LF Solder Joints

We are examining the effect of isothermal pre-aging on the reliability of solder joints in thermal cycling test. Samples were pre- aged at 125°C for 4 and 12 weeks and subjected to 0-100°C shock test. Careful precipitate measurement is performed on samples to monitor the precipitate coarsening prior to start of shock test. Results showed considerable amount of precipitates coarsening after four weeks of aging. The shock test is still in progress. Effect of different pre-aging condition and various strain levels (different pitch sizes) on reliability and failure mechanism will be reported in the next meeting.

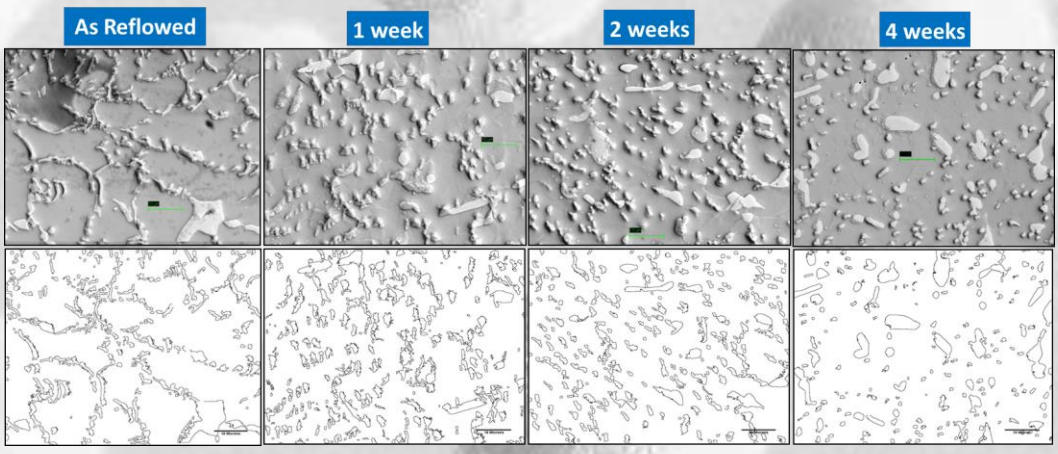


Figure shows precipitate coarsening of 10 mil SAC 305 solder joints reflowed on Cu substrate (the component surface finish in Electrolytic Ni/Au). Significant coarsening after four weeks of aging at 125°C was observed.

MAT1A: Underfill Studies

Experiments with two more underfills (one of them reworkable) continued. Flow studies between glass slides, using the apparatus mentioned in the October Newsletter, have commenced. It was found that while reflowed paste deposits kept the glass slides together with sufficient strength, they did not always give a uniform gap, so currently feeler gauges are used as spacers to control the gap during reflow but are later removed so as not to interfere with underfill flow. The position of the flow front as a function of time is determined afterwards by analysis of video recordings of the runs.

MAT6B: Die Attach and New LF Alloys

Work continues on our assessment of Pb-free die attach materials. We've finished assembling test coupons with a 92Sn-8Sb filled epoxy. Currently we are studying the joint microstructure and the interfacial reactions. Joints will be shear tested after reflow and after 3X Pb-free reflow. We have recently received a Ag-sintered paste material for evaluation. A dispense process will be developed for this material in January.

REL2A: Lead-Free Phenomenological Model Update

It is well established that aging tends to lead to major changes in the properties of SnAgCu solder joints, but the practical consequences are commonly misinterpreted. Notably, the effects of long term aging cannot be simply reproduced by accelerated aging at a higher temperature. Thus, we have shown the sensitivity to aging temperature to be different for solder hardness than for creep and strength. Most recently, we have now also shown apparent effects of aging at room temperature for 2 years to be partially reversed by subsequent annealing at 125C. This is tentatively explained by the combined effects of the growth of Ag3Sn and Cu6Sn5 precipitates together with solution hardening associated with the initial supersaturation of the Sn with Ag and perhaps Cu. More complicated effects of accelerated aging on subsequent fatigue life, including systematic variations with component design, seem consistent with partially counteracting effects of reductions in fatigue resistance and in stiffness (and thus cycling induced stresses).

material for evaluation. A dispense process will be developed for this material in January.

High Temperature Electronics Research

We have started two studies for our high temperature electronics research program. The first study is looking into the effect of added Sn on the microstructure and mechanical performance of 92.5Pb-5Sn-2.5Ag. For this study 20mil solder spheres with various Sn concentrations are being reflowed on our high temperature circuit board for microstructure and mechanical strength evaluation. Ball shear tests will be conducted at 25°C and 200°C using a heated stage on the Dage 4000plus. The shear strength will also be measured after high temperature storage (HTS) at 200°C for 1000hrs. Shear tests will be conducted at 25°C and 200°C after HTS. The microstructure evolution of each alloy will be studied as a function of added Sn concentration and temperature, up to 200°C. Thus far we've completed shear testing at 25°C and an initial assessment of the microstructure. The second study is ball shear testing of various high temperature alloys used in downhole electronics. A list of the alloys that will be tested is provided in the table below. Each alloy will be tested at room temperature and 200°C. Alloys will also be sheared after HTS at 200°C for 1000hrs. Shear tests will be conducted at 25°C and 200°C after HTS. The microstructure of each alloy will be studied as a function of temperature.

Composition	Liquidus (°C)	Solidus (°C)
92.5Pb-5Sn-2.5Ag	296	287
97Pb-3Sb	320	300
92.5Pb-5In-2.5Ag	310	300
85Pb-10Sb-5Sn	255	245
97Pb-3In	320	310
90Sn-10Sb	252	242
Bi-Ag-X	-	262