AREA Consortium



*Dear Members;*

We had a very successful planning meeting on October 3rd and 4th held at Binghamton University. In addition to our usual research updates and student poster session we also held breakout sessions on topics we intend to include in the 2013 research efforts. These topics included: Path Finder Builds, LF Alloy Microstructure and 2nd Level Reliability, Rework, TIMs, HMP Alloys, Underfill, Adhesives, Creep Corrosion, Vibration and Modeling.

Expect to receive the 2013 Plan prior to November 15th.

2013 will be a very productive year with many interesting topics that will continue to provide value to our members. This Newsletter will focus on many of the plans we are working on for 2013.

Martin Anselm, Manager AREA Consortium

## Equipment News

We now have fatigue capability (both shear and pull, including HBP) with the 4000Plus Bond Tester! Dage recently released a fatigue-capable software which we installed in our machine and tested. The HBP fatigue in the 4000Plus is more automated, better controlled and easier to use than the 4000. Currently, we are running tests to compare fatigue results obtained with the two machines.

## Thermal Interface Material Update

The TIM load fixture has been built (see image below). This fixture will compare the thermal performance of several different TIM pads as a function of pressure. We are currently evaluating the effect of thermocouple position on the measured thermal resistance of the TIM layer. We are also designing a calibration fixture for our Instron tensile testing machine to correlate spring displacement to applied load.

## Website Updates

- Component Database!
- October meeting presentations ***with audio!***

## Underfills and Surface Finishes

We are looking into the latest in underfills (of various types) for our planned underfill project. We plan to look at several underfill properties, including flow characteristics, application ease, flux compatibility, and of course performance after assembly. Soon members will receive a letter soliciting information to identify materials that are of interest. Our generic test board, currently under design, will be used for these tests. We'll also be looking at new, and revisit old, surface finishes.

## HMP Solders

We will begin studying the effect of impurities on the melting behavior of HMP solder in early November. Pure Sn powder will be added directly to 92.5Pb-5Sn-2.5Ag in increments up 5% wt. The mixture will be reflowed, and the solidus and liquidus temperature will be measured with Differential Scanning Calorimetry (DSC).

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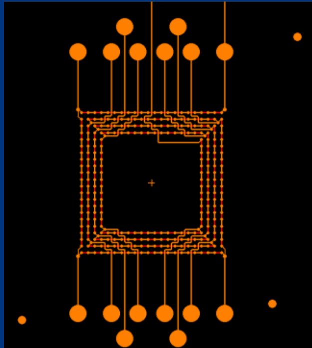
## *Impact of Partial Pad Cratering on PCB Reliability*

Originally scheduled to begin in early 2013, we have already received the BGAs and expect the test boards to arrive in late November. As stated in the project proposal, we intend to evaluate degradation in product life due to partial PCB pad cratering initiated by spherical bend. "Partially damaged" samples created by stressing the boards to 50 and 75% of the inflection strain will be subjected to accelerated thermal cycling, drop, cyclic bend, and possibly vibration in an attempt to determine how much the predamage accelerates the pad cratering failure. Of course, undamaged samples will also be tested for comparison. Our initial experiments will focus on the 370HR laminate, but other materials may follow, depending upon our results. If everything goes as planned, expect preliminary results at the February meeting.



## *Universal Process Test Vehicle 2013*

We are currently designing a Universal test board which will be used for several upcoming projects. The board will contain a selection of off-the-shelf dummy package types including BGA, CSP, WLP, SMR, TSSOP, MLF, ePadTQFP, tsCSP, LGA, FusionQuad, and flip-chip. Different surface finishes will be acquired. ENEPIG, ENIG, LF-HASL, Entek OM, and Pallaguard have been proposed. In addition to surface finish evaluations, this board will be used for conformal coating studies, underfill evaluations, solder alloy studies, and rework development. Our goal is to have the design completed and submitted for fabrication by mid-December so that we can have the boards in early 2013. We welcome member feed back regarding materials (pastes, fluxes, alloys, conformal coats, underfills, etc.) that we should be evaluating.

## Creep Corrosion

ENEPIG had not been included in the surface finishes we tested in the past. A series of Humid Sulphur experiments using ENEPIG boards from various sources was started recently. The "as received" samples are already in the chamber. Coupons with various flux residues and/or different levels of chloride contamination will be tested next.

## *Package Reliability Test Board*

If there is sufficient interest, we will acquire a test board for evaluating new Pb-free packaging technologies which will include devices that you, the member, have provided. We have decided that the board will be produced with ENEPIG, but we would also like to get the same number of samples with either CuOSP and/or Lead-free HASL. We have also received requests to look at SnPb assemblies on ENEPIG and if there is enough interest we would certainly consider that. The board will most likely be around 2.0mm thick with 10 to 12 copper layers and will utilize PTH and microvias where necessary. We ask that participants provide at least 48 lead-free samples and/or 24 SnPb samples for testing plus 2 additional devices for setup and evaluation purposes. Reliability analysis will be performed by subjecting the test vehicles to -40/125C thermal cycling.

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## Lead-Free Failure Mechanisms

We continue our research on the failure mechanism of lead free solders in thermal cycling tests. Samples in both harsh (-40/125°C, -55/150°C) and mild (20-80°C) cycles have been analyzed for both SAC (305) and SnPb alloys. We are also planning to evaluate the effect of preconditioning (pre-aging) on the board, component and solder joints before and after thermal cycling tests. We are considering a collaboration with Binghamton University to measure the strain induced in solder joints. A careful failure analysis will be performed. Any input from the members on the project is valuable.

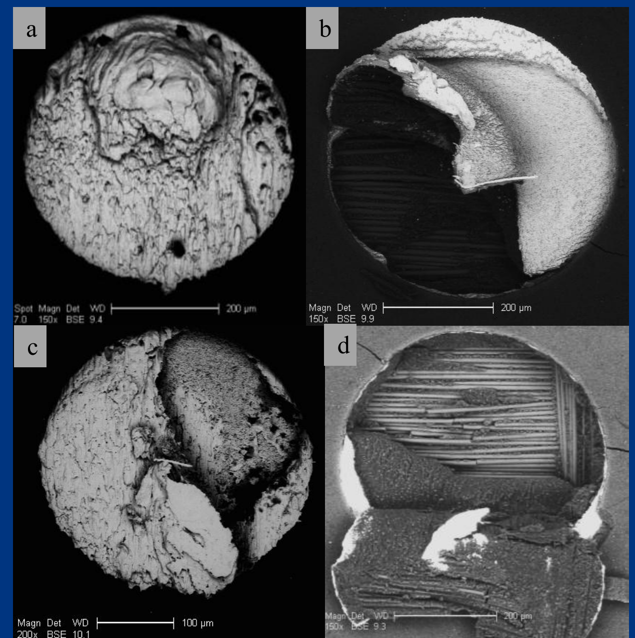
## LF Mechanical Model

***Systematic studies of the evolution of microstructure and damage*** in SnAgCu solder joints under a wide variety of thermal cycling conditions led us to a general picture and model. We currently propose, as a practical working approximation, that the life scales with the time (number of cycles) to completion of a network of high angle grain boundaries (recrystallization) across the high strain region of the joint. We have furthermore shown how this depends on the repeated alternation between high and low temperatures. Our working hypothesis is that life will depend on the work (or entropy increase) at low temperatures together with diffusion (temperature and time) at high temperatures.

## New Solder Alloys

The work is in progress to evaluate the properties of "New alloys". Different solder alloys with various amounts of dopants are being considered. Mechanical tests on solder joints are going to be completed (low and high speed shear strength, shear fatigue). Depending on the amount of solder balls and components that we can receive from members, reliability testing (drop/thermal cycling) is going to be performed.

Following figure shows the various failure modes observed in the high speed shear test



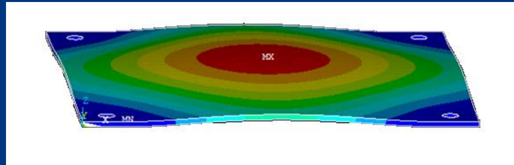

a: bulk solder, b:Pad cratering+IMC, c:bulk solder+IMC, d:pad cratering

## Thermal Cycling Model

Model BGA assemblies are currently undergoing thermal cycling tests according to a carefully designed matrix of cycling parameters, varying dwell temperatures and dwell times separately. Tests include -40/125C, 0/100C, and 0/80C with different dwell times, solder joint dimensions and distances to neutral point. Results of this and previous systematic studies will be analyzed on the basis of our working hypothesis with the goal of proposing a quantitative acceleration model. So far, test results have confirmed the specific effect of varying only the minimum dwell time. Expectations are that we will have significant results in time for the February consortium meeting.

## *Vibration modeling and testing (Q. Su, J. Pitarresi)*

A finite element model of the circuit board to be used for our vibration reliability studies has been created with clamped boundary conditions at the through-hole locations. Scanning laser vibrometer measurements were used to measure the vibration of a circuit board driven with an electrodynamic shaker. The predicted and measured board deflections are shown below. The first resonant frequency for this structure was predicted to be 425 Hertz and measured to be 550 Hertz. More accurate material properties are needed to obtain better predictions. The parameters used in the model were obtained from literature. Actual parameters will be obtained using impulse hammer testing methods for circuit boards with free boundary conditions.



FEA prediction: 425 Hertz Scanning laser vibrometer measurement: 550 Hertz

## *A Letter from the Associate Director*

## *A Review of SMTA International Conference from the APL Perspective*

The SMTA International Conference and Exhibition was very successful and attended by over 700 conference attendees. The APL in conjunction with its partner, Binghamton University and member, Alcatel Lucent, published 5 papers which were all well attended and the immediate feedback was very positive. The papers are available on the Consortium website along with our marketing materials. These are available for you to download and share with your colleagues and peers in the industry. We were fortunate to have Richard Coyle present the research done in collaboration with Michael Meilunas on interposers as a solution for backward compatibility. We are looking to identify other AREA consortium members that are interested in presenting research in collaboration with the AREA consortium.

In addition, the APL hosted its 2nd Annual Technology and Networking Session at SMTA International. At this meeting, Martin and I introduced the APL and explained the research that is ongoing and planned within the AREA consortium. It was well attended and many individuals from our member companies who normally cannot make it to our meetings in Binghamton were in attendance. This session was also attended by many individuals who are interested in AREA membership. A thank you goes out to those members who took the time to speak with these individuals and discuss the merits of AREA membership. Your continued support is greatly appreciated. All had a good time due to the open bar and finger food. We look forward to returning to SMTA International next year in Fort Worth and hosting our 3rd Annual Technology and Networking Session. Mark it on your calendars October 13 – 17, 2013.

As we move into 2013, there are many opportunities for us to interact, visit your facility, and reach out to your colleagues who are not able to come to the AREA consortium meetings. We are also visiting various regions of the US as speakers are SMTA events. We will keep you up to date as to our plans and hope to take advantage these visits.

Best Regards,

Denis

Barbini@uic.com

603 828 2289