Dear Members,

Solder paste printing is proving to be an area of very active interest among our membership and the lab has been quite busy with several substantial paste printing projects. You'll hear about several of these at the upcoming fall consortium meeting. Other topics on the meeting agenda will showcase the collaborative nature of our 2015 research activities with our industrial partners selected as the best spokespersons for several projects. The meeting will be held on October 14th and 15th at our usual venue on the Binghamton University research campus. Please join us. More details will be forthcoming through direct electronic mailings.

A wholesale migration of our consortium web content from our own private site back into the Universal Instruments corporate web pages is underway. Starting at the www.uic.com home page, you can now drill down (>Solutions>Advanced Process Lab>AREA Consortium) to find all our on-line content: research plans, newsletters, research reports, meeting content, process manuals, etc., [direct link: www.uic.com/solutions/apl/area-consortium/]. The full content migration is not quite complete but the new UIC hosted pages are live for your review and comment. Site security protocol remains the same so you will use your existing login credentials to access any members-only content. Our historical stand-alone site at www.uic-apl.com remains active with a link back to it included from many of the new UIC pages.

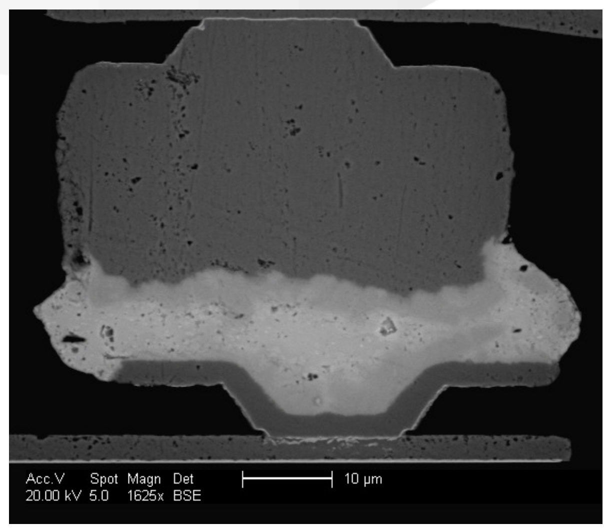
Sincerely,

Jim Wilcox
Consortium Manager

REL12A. Fine Pitch Copper Pillar Interconnects

Our copper pillar interconnect project has seen substantial progress over the last few months. This project is a collaborative effort among our consortium staff, IBM Microelectronics, Corning and Binghamton University. Test hardware was designed to emulate interconnects found in 2.5D packaging structures. Interposer substrates have been fabricated of both glass and silicon. These substrates have been metallized in the IBM 300mm wafer fab. Large (12mm) test die were also fabricated by IBM with various copper pillar designs (diameters from 30 to 150 µm at pitches of 90 to 240 µm). We have developed a mass reflow process in our SMT lab to assemble the various sizes of the solder tipped copper pillars (see figure).

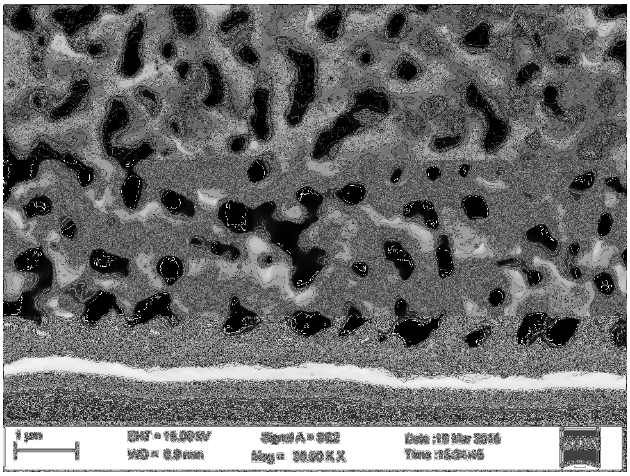
Effects of several interconnect design parameters such as solder composition, solder volume, pillar height and under bump metallization on reliability in drop/shock and thermal cycle stresses will be evaluated. Results will be presented in October AREA meeting.



SEM image of a 50 µm pad diameter copper pillar assembled to a Ni/Au pad on a glass substrate. The height of copper pillar is 25 µm.

MAT6B. Sintered Silver Die Attach

During our summer webcast on sintered-Ag die attach we highlighted differences in the microstructural evolution of thin (<20µm) and thick bond lines (>80µm) during high temperature storage. Thin bond lines were shown to form a depletion layer above a dense Ag layer formed on the DBC substrate. The depletion layer was found to be the weak link in the thin bond line joints during die shear testing. While a dense Ag layer also formed in thick bond samples, a depletion layer did not. Consequently the strength of thick bond line joints increased with increasing storage time.



SEM image of DBC interface of sintered-Ag joint after 2000 cycles of -50˚C to 200˚C thermal shock.

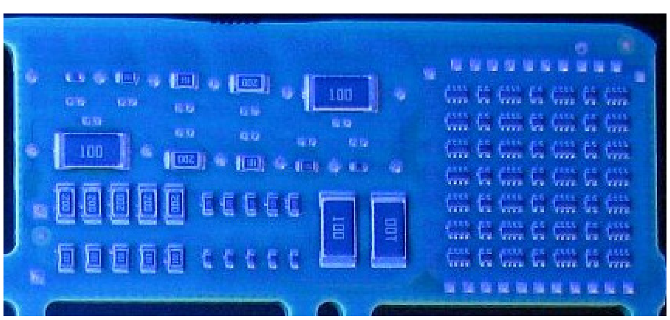
Thick and thin bond line sintered-Ag samples were also subjected to thermal shock testing. Both sample sets showed poor shear strength after 2000 cycles of thermal shock (-50˚C to 200˚C). Failure analysis revealed similar failure locations and mechanisms for thin and thick bond line samples. The failure mode was related to the interface microstructures just above the dense-Ag layer on the DBC substrate and just below the dense Ag layer at the die interface. A cross-section of the DBC interface of a sintered-Ag joint after 2000 cycles is shown.

Current efforts are focused on optimizing the interface microstructures to improve thermo-mechanical reliability.

MAT8C. Conformal Coated Resistor Corrosion

The ability of conformal coating to suppress sulfur induced corrosion of resistor finishes is known to vary widely by coating material. SMD resistors without anti-sulfur finishes in various formats (0402, 0603, 0805, 1206, 2512) have been assembled and coated with a range of different conformal coating material types: silicone (SR), epoxy (ER), acrylic (AR), urethane (UR) and some new nanocoating materials (see table). These coupons will be used to compare the corrosion resistance imparted by the various conformal coating materials. Surface corrosion will be induced in a Flowers-of-sulfur chamber at 105°C.

Type	Coating
SR	Dow Corning 2620
ER	Humiseal 2A53
AR	Humiseal 1B73
AR	Conap CE-1170
UR	Humiseal UV40
UR	Humiseal UV50
UR	Peters SL1301 ECO-FLZ/23
	Semblant PlasmaShield 200
	Semblant PlasmaShield 400



Resistor arrays coated with Peters SL1301 ECO-FLZ/23 urethane (UR) material and viewed under UV light.

The resistor arrays are electrically stitched to monitor functional resistance changes as corrosion progresses. Coupons of each coating cell will be tested in the coming weeks along with uncoated control samples. Failure rate results after 500 and 1000 hours of sulfur exposure are expected by the October meeting.

MAT1B. Reworkable Component Underfills

Accelerated thermal cycling of TB2014U assemblies is ongoing, including assemblies underfilled with encapsulant materials E and F along with similar reference assemblies being tested without underfill. Enough failures have occurred among these tested parts to draw some preliminary conclusions. Three additional underfill materials have been subjected to our standard flow testing, both with glass slides and on actual component assemblies. Of those, two materials have been selected to underfill component assemblies for further thermal cycle reliability evaluation.

The new underfill test boards, designated TB2015U, have been received. These boards will be populated with Sn-Pb eutectic soldered components. Half of these new assemblies will be washed prior to underfilling to explore the effect of board cleaning on interconnect reliability. Most of the components on the TB2015U board are the same as those used on TB2014U. Since the latter board was populated solely with Pb-free solder components, direct comparisons between the two solder alloys may be possible in those instances where the same material is used for underfilling.

MAT6D. Passive Device Surface Finish

Work has begun on the Passive Device Surface Finish project. This new research seeks to identify the reliability of high temperature interconnect and surface finish combinations in high temperature thermal cycling environments. Five high temperature interconnect materials along with five device surface finishes will be evaluated according to the test plan shown in the table below. Using high temperature capacitor devices, the indicated combinations will be screened through as-reflowed and aged microstructure evaluations as well as room temperature and high temperature (200˚C) shear tests. Interconnects with promising behavior will be further tested in thermal shock (-50˚C to 200˚C). A project update will be presented at the AREA Consortium meeting in October.

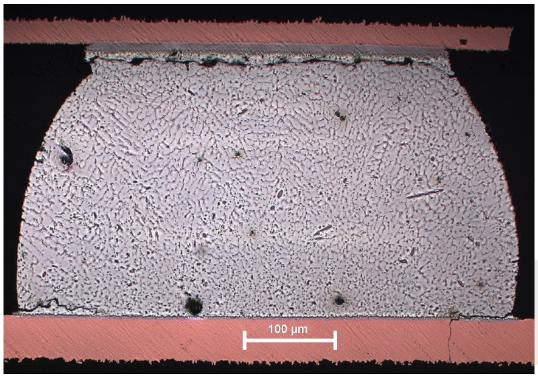
MAT6D Test Plan

Surface Termination	100% Sn over Ni	85Pb15Sn over Ni	PdAg	Thick film Au	Thick film Ag
Alloy 151	X	X			
BiAgX™	X		X	X	X
Innolot™			X	X	X
Ag-Paste			X	X	X
EPO-TEK® H20E			X	X	X

MAT2D. Effect of Copper Foil Treatment on Pad Strength

This project evaluated laminates fabricated with various combinations of two different resin materials and four copper foil materials each differing in the laminate side surface roughness and the presence or absence of an adhesion promoter (primer). The Angled Hot Bump Pull (HBP) technique was initially used to measure the strength of laminate copper surface pads of two different diameters. These tests were concluded and the same coupons were used for perpendicular Cold Bump Pull (CBP) pad strength measurements. Pads of three different diameters were used for CBP. Some differences in pad failure modes were noted between the two techniques, but in both cases pad cratering was overwhelmingly the dominant failure mode. The results of CBP were consistent with the conclusions from HBP testing. The experimental phase of this project is complete.

REL3B. Vibration Testing … Sequential Loading Effects



Optical micrograph of a SAC 305 CABGA208 joint failed after fixed frequency vibration

A test was designed to investigate possible synergistic effects among various environmental stress conditions when sequentially applied (*i.e.*, vibration loading prior to thermal cycle and vice versa) on the reliability of various lead free solder alloys in different SMT joint configurations. BGA and LGA style joints of SAC105 and SAC305 composition will be evaluated in this study. Microstructural analysis is in progress to identify failure mechanisms under various loading conditions.

2015 SMTA International Conference

We will again be showcasing some select highlights from our research archives at the upcoming SMTA International conference in Rosemont, IL .

<u>HE1: Reliability of Components in Harsh Environments</u> (Monday, September 28)

- **Isothermal Fatigue of High Temperature Solder Joints**
  <u>Harry Schoeller</u>, Universal Instruments Corporation

<u>LF1: Universal Instruments Consortium Pb-Free Project Update</u> (Thursday, October 1)

- **Metallization and Surface Finish Effects on Pb-Free WLCSP Thermal Cycle Reliability**
  Jim Wilcox and Michael Meilunas, Universal Instruments Corporation
  (to be presented by <u>Denis Barbini</u>)

- **Harsh Environment Reliability of Micro-Leadframe (QFN) Components and Conformal Coating Effects**
  <u>Jim Wilcox</u>, Michael Meilunas, Universal Instruments Corporation
  and Martin Anselm, Rochester Institute of Technology

- **Thermo-Mechanical Evaluation of Alternate Pb-Free Die Attach Materials**
  <u>Harry Schoeller</u>, Universal Instruments Corporation
  Sandeep Mallampati and Junghyun Cho, Binghamton University

If you are planning to be at the conference, please stop in and give us a listen. You might pick up some extra insight from these historical projects on the second time around. And of course it's always good to have the support of our membership in the room when we're using your content to entice some broader participation from the industry at large.