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Next Generation Organic Solderability Preservatives (OSP) for Lead-free soldering and Mixed Metal Finish PWB's and BGA Substrates

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Abstract
With the electronics industry rapidly moving to lead-free soldering and requirements for long term reliability of the assembly becoming more critical, fabricators and OEM's must determine the most cost effective and reliable means of achieving bare board solderability and component attachment. OSP's have long provided a reliable and inexpensive means of satisfying these requirements. However, greater solderability requirements, (measured as joint strength, paste spreadability and hole fill), and higher temperatures of lead-free soldering, have greatly diminished the use of conventional (standard substituted benzimidazole based) OSP's. However, with the development of third and fourth generation organic solderability preservatives based on a novel aryl-phenyl imidazole compound, OSP has regained its leadership role as a final finish, particularly in Asia and Europe. In addition, the technology shift to bare copper PWB's with selectively plated gold features is requiring OSP's that do not tarnish or deposit on the gold. This paper will explore the development and implementation of the next generation OSP for lead-free soldering. The OSP performance will be compared to other surface finishes (ENIG, ImTin, Immersion Silver, conventional OSP) in terms of solder paste spreadability, solder hole fill and solder joint strength. Reliability studies will be performed with both standard lead based solders and lead-free solders and include solderability performance with multiple reflows and artificial aging conditions.

Introduction
The trend toward alternative surface finishes to promote the solderability of bare copper surfaces has been well defined. While it is true hot air solder leveling, (HASL) is till the predominant surface finish; alternative technologies are being implemented for a variety of reasons:

- ✓ Environmental and safety concerns over lead
- ✓ The need for a coplanar surface
- ✓ Lowest possible ionic contamination of the surface
- ✓ Fine-pitch device assembly
- ✓ Reliability
- ✓ Cost

Driven by the technological shift to the SMOBC Process, HASL provided a quick and simple way to provide solderability protection for the exposed copper by depositing a thin layer of eutectic solder on the exposed copper surfaces. Certainly, this process has serves the fabrication and assembly industry well for many years. Nevertheless, fine-pitch surface mount and the use of BGA and Flip Chip technologies will continue to increase, and the very tight tolerances of the mounting pads for these technologies will preclude the future use of HASL.

On the other hand, OSP Technology (Organic Solderability Preservatives) is environmentally friendly, provides a coplanar surface, and requires very low equipment maintenance. The process is designed for horizontal conveyorized processing. However, vertical immersion systems are also easily integrated into the printed wiring board fabrication process.

Various industry consortia are actively exploring alternatives to HASL. The documentation relating to the requirements for alternative surface finishes have been well publicized at many industry forums. Pressure to eliminate lead in electronics assemblies is forcing fabricators and OEM's to reevaluate their surface finish and joint attachment procedures. Many of the requirements, in fact, are obvious. Regardless, the PWB fabrication industry needs to work closely with contract manufacturers and end users to fully appreciate the true impact of technology trends. These trends are significant and include:

- ✓ Surface mount continues to increase at the expense of through-hole with finer and finer features.
- ✓ The use of non-tin/lead coatings and surface finishes will increase. Surface finishes such as electroless nickel/immersion gold, OSP and immersion tin will be utilized.
- ✓ With political movements toward banning lead in all electronic assemblies gaining significant momentum, lead-free

solder pastes and wave solder materials will be adopted.

- ✓ The alternative surface finishes must perform through multiple thermal cycles with less active pastes and fluxes.
- ✓ The use of multiple metal finishes on the same bare board will place new emphasis on the compatibility of coating with each other, and the actual assembly module.
- ✓ Increased I/O demand and reduced lead pitch will require much tighter controls over the processes used to fabricate the bare board. High I/O packages will test the process limitations in imaging, etching, solder mask and surface finishes.
- ✓ Chip scale packages and BGA will find increased use as an interconnect medium
- ✓ Assemblies are becoming harder to inspect rework.

The trends listed above are only a snapshot of the many issues that fabricators and assembly companies face. However, those listed are the ones that most closely reflect the trends influencing the solderability of components and the bare board surface. This fact relates mostly to the actual selection and performance of the surface finish. Regardless, the finish must be able to perform under a variety of conditions, consistently and reliably.

Trends towards Mixed Metal Finish

In recent years, in order to achieve high-density surface mounting on printed wiring boards, the number of terminals of circuit components have been increasing, and the pitch of the terminals has been significantly reduced. With the trend for increased packaging density has come the use of COB (chip on board), flip chip and TAB (Tape Automated Bonding).

In many instances, the surface mounting of such components may be required on PWB's with copper pads and other features plated with gold, silver, tin or solder. These mixed metal finish boards are becoming very common today and the surface treatment of such circuits will continue to grow in importance. The demand was such that a water soluble surface-treating agent, that was capable of protecting the bare copper form oxidation without leaving a film on the other metals, needed to be developed and implemented. In other words, the need for an OSP that selectively bonds to the copper without adversely affecting other metals such as gold or solder was established. (See Figure 1)

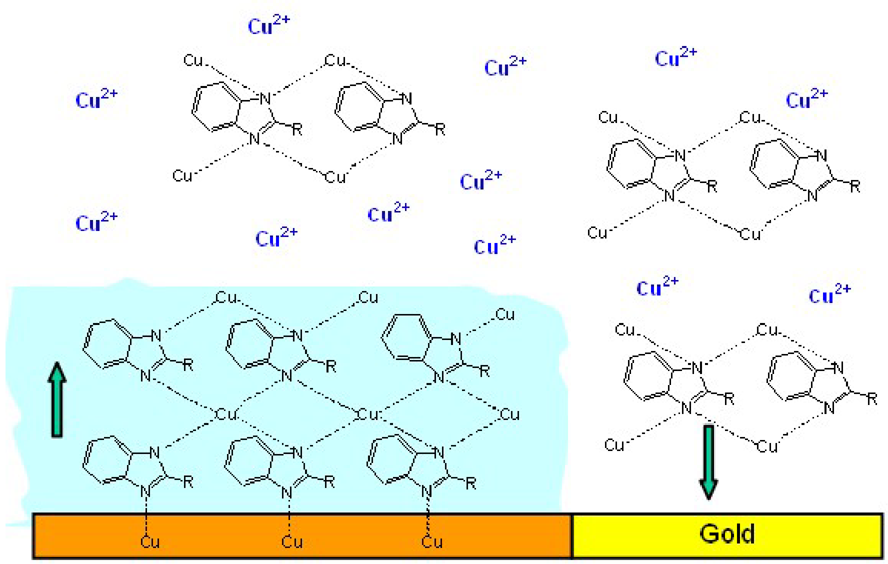

Figure 1 – OSP Deposit on Gold

Conventional OSP processes based on long chain alkylimidazole compounds and substituted benzimidazole compounds functioned adequately to protest the bare copper. However, these materials also deposited a significant film on the other metals such as gold, tin and solder. This additional film interfered with subsequent operations such as wire bonding, and surface mounting of Quad Flat Packs on solder surfaces. In addition, the contact resistance on the gold increased to unacceptable levels. Thus, when PWBs are fabricated with multiple metal finishes, the metals such as gold or solder would have to be masked to prevent the OSP film formation on their surfaces. In some instances, the coating would have to be removed with alcohol, adding additional labor and cost to the fabrication process. A factor in promoting this film formation on the metal surfaces in the copper contained in many organic solderability formulations. The copper ions form a complex with the active azole ingredient in the OSP chemistry and actually help to promote film growth. When a copper-solder mixed metal board is processed through such a process, the OSP forms on the solder and has the affect of discoloring the solder, making long-term solderability literally impossible to achieve.

It has also been determined that the copper ions that are part of the OSP protective film contribute to ionic contamination, a situation being constantly scrutinized by assembly houses and end users. It is desired to keep ionic residues as low as possible. It has been demonstrated that the copper contributes to the staining/darkening of the solder and causes undo build-up of residue on the gold.

Therefore, it was imperative to develop an OSP process that would selectively deposit on the bare copper surface only, with low residual ionics. However, a film formed on the copper must have sufficient ability to maintain the solderability of the base copper through multiple thermal excursions and with a variety of low activity ware soldering fluxes and pastes.

Compatibility with Lead-Free Solder

Processing PWB's with mixed metal finishes is just one of the challenges facing the electronic interconnect industry. The second major and no less significant challenge is providing a printed wiring board finish that will maintain solderability and provide a highly reliable joint with lead-free solders. This is no easy task. A multitude of different lead-free formulations and interactions with fluxes will influence reliability. The surface finish must foster the optimum wetting and intermetallic formation under multiple thermal excursions and higher soldering temperatures required for lead-free solders. How will the surface finish react to these greater temperature and time stresses? What will be the effect on solder paste spread and hole fill after thermal excursion? This is the critical success factor-integrity of the final finish and its ability to preserve solderability. Certainly, the end user often specifies the finish due to personal preference, history, cost, reliability, fit with certain PWB designs, etc. Regardless, a walk through any EMS company will provide the visitor with the full range of finishes, depending on the various requirements of the customer.

The latest generation based on a novel Arylphenylimidazole (Figure 2) shows much higher heat stability and can easily withstand the peak temperature of reflow for typical lead-free solders. TG (Thermogravimetry) curve indicates the weight increase and decrease, and DTA (Differential Thermal Analysis) curve indicates the exothermic and endothermic reaction of OSP coating itself (Figure 3). An OSP coating composed of an Alkyl benzimidazole compounds, which are still widely used in the market, begins to decompose around 250 °C as shown in Figure 4 (top graph) This is the typical peak temperature for lead-free soldering. However, the latest OSP composed of Aryl-phenylimidazole technology shows much higher decomposition temperature. (around 350 °C) shown in the lower graph in Figure 4. Each OSP manufacturer should not disclose the composition in detail, but typically just brand name. However, this is one of the most important factors to determine the best OSP in conjunction with lead-free solder.

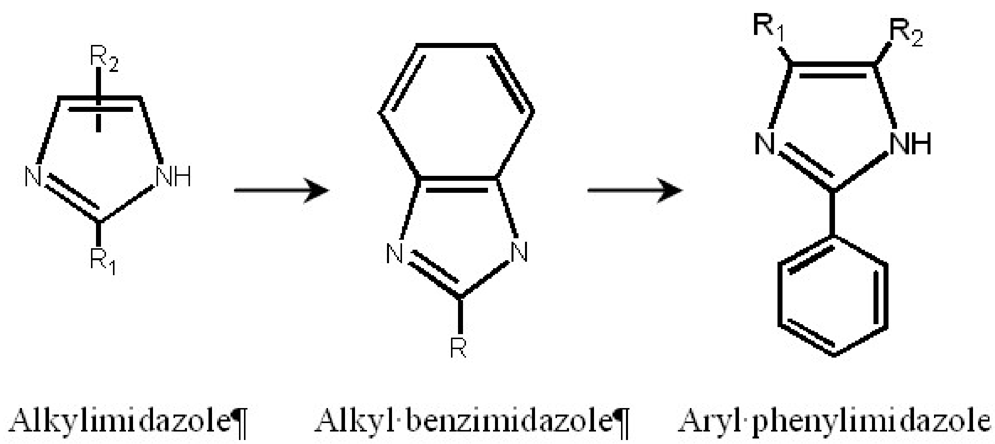

Figure 2 – Development of Active Ingredient

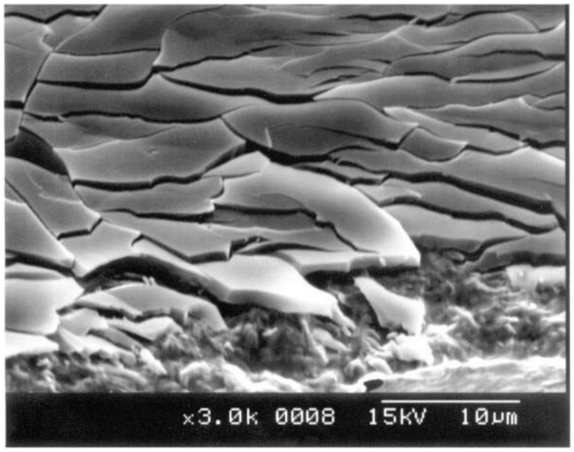

Figure 3 – OSP Coating

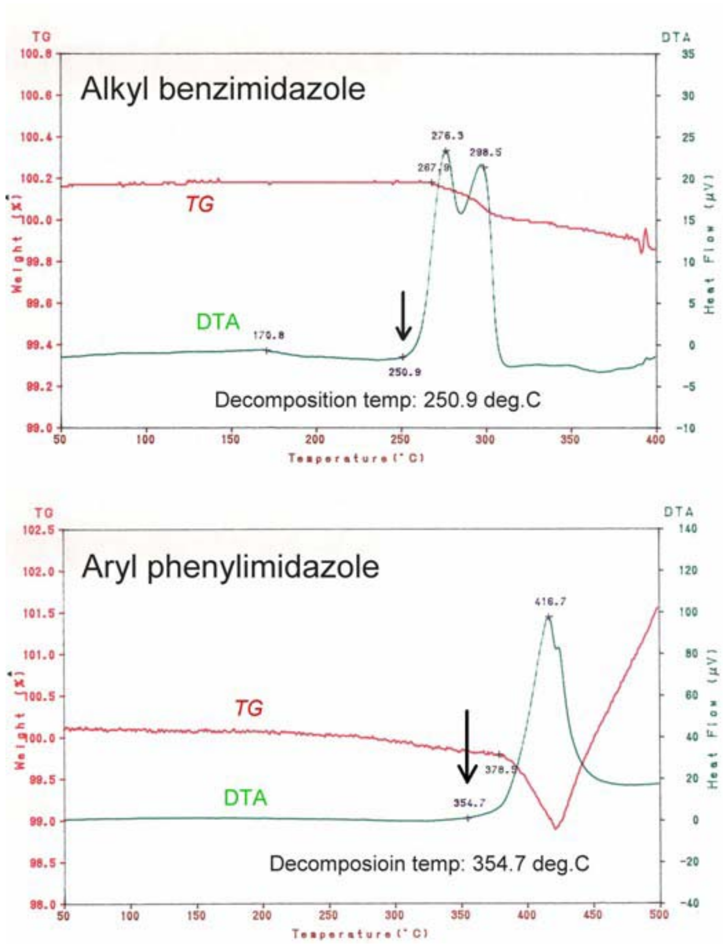

Figure 4 – TG-DTA Curve

The Chemistry of the Process

For this process, a unique imidazole compound was synthesized as the active ingredient of the OSP. (US. Patent #5,795,409) This unique compound is solubilized in water and a nominal of amount of acetic acid. Acetic acid was chosen over such other acids as formic. The main reason is that acetic acid is less volatile than formic acid due to lower vapor pressure (Figure 5). This attribute contributes to maintaining a very stable pH range, which is necessary in building a uniform and sufficiently thick organic coating for solderability protection. When acids such as formic acid volatilizes, the concentration of the active ingredient can increase, causing the organic material to build the film abnormally thick and in a rather non-uniform fashion. This leads to solderability problems ranging from poor solder paste spread to heavy organic residue being deposited onto other metals and laminate surfaces.

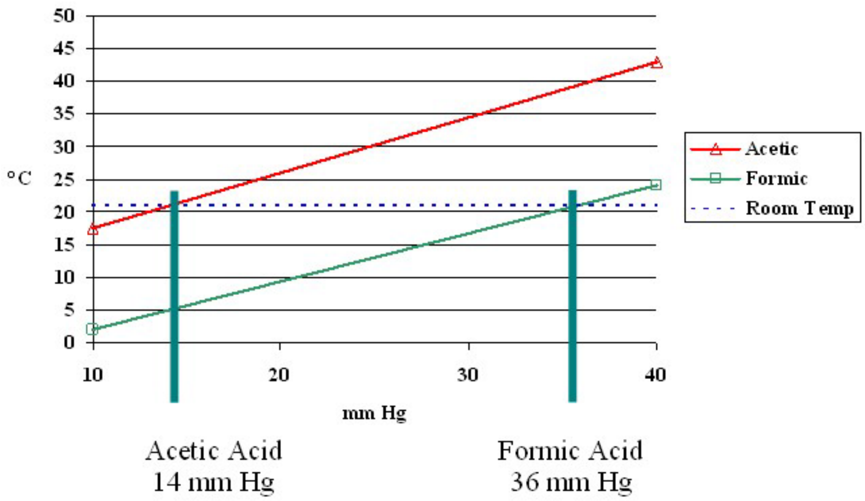

Figure 5 – Vapor Pressure of Acetic Acid vs. Formic Acid

This process employs a combination of a phenyl imidazole compound mixed in an aqueous solution with acetic acid, a complexing agent and a water-soluble ion compound. The combination of these additives permits the uniform coating of the organic film on the copper without building any appreciable amount on the non copper surfaces. After the printed wiring board has been prepped in an acid cleaner, followed by a micro-etch, the OSP coating is applied to the PWB by either dipping, spraying, or flood coating. While the OSP film thickness is self limiting, commercially available OSP's provide thickness from 1000 angstroms to as high as 6000 angstroms. In order to prevent excessive thickness of the OSP film on copper as well as negating any appreciable deposit on gold or other metals (including silver), a unique OSP formulation was required. One of the key developments of this process was to be able to grow a film thickness (as uniform as possible) without the need for the addition of copper ions to the OSP solution. Most commercially available OSP's cannot maintain a sufficient film thickness in the absence of copper. The unique phenylimidazole compound shown in Figure 2 provides sufficient film thickness without depositing any organic material on gold or silver. This process uniformly deposits 1000-1500 angstroms of the organic film on copper.

OSP for BGA Substrate

Superior solder joint strength is the prime reason that most mobile phone manufacturers have moved to adopt OSP as the primary finish for their PWB's. Fundamentally for past several years, BGA substrate companies are also interested to evaluate OSP as an alternative of ENIG. However, the assembling process prior to solder ball attach is totally different from normal printed wiring boards. Generally, the process includes several high heat incursions, including a long curing process for EMC (Epoxy Molding Compound). The process (detailed below) certainly can affect solder paste spreadability: (See Figure 6.)

1. 120-130 °C for a few hours to remove the moisture in the substrate
2. Mount the chip and cure the adhesive around 170-180 °C for 10-20 min.
3. Plasma irradiation to clean the gold surface prior to wire bonding, as well as make the solder mask surface rough in order to improve the adhesion with EMC.
4. Cure EMC around 170-180 °C for several hours.
5. Solder ball attach with unique soldering flux on the bottom side of BGA substrate

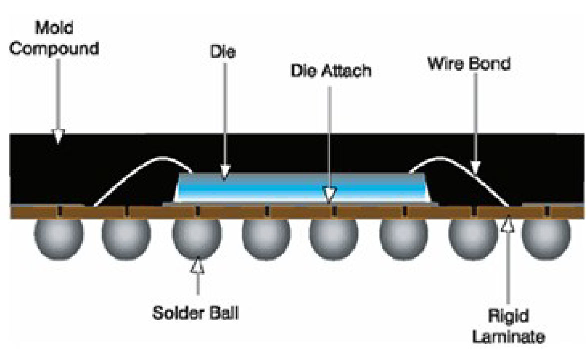

Figure 6 – Wire Bond CABGA Cross Section

On the other hand, the heat conditions could grow copper oxidation underneath OSP coating, and nickel oxidation underneath gold plating, and finally affect the solder joint strength. The comparison study among three different OSPs, Immersion silver and ENIG was carried out, as well as the process and cost consideration.

Plasma Irradiation

Plasma irradiation should be necessary only for the topside of BGA substrate to clean the gold surface and make the solder mask surface rough. However, the irradiation atmosphere is usually filled with certain amount of argon gas to diffuse the plasma ray efficiently, so that OSP coating on the bottom side also could be exposed and removed. Finally, the thickness is quite important to keep the copper away from oxidation during the heat conditions.

The thickness after 1-3 times of plasma irradiation was compared. The coating was reduced after the first irradiation significantly, because of probably volatility of the surface layer with weak bonding between imidazole and copper, while there is no significant change by the second and third one. The proper and the minimum thickness of OSP coating fully depend on the basic property of the active ingredient as Figure 2. Although OSP composed of Alkyl benzimidazole requires thicker coating to show the best properties, a relatively thinner coating of 0.10 um is sufficient to for the aryl-phenylimidazole to maintain sufficient solderability. (See Figure 7.)

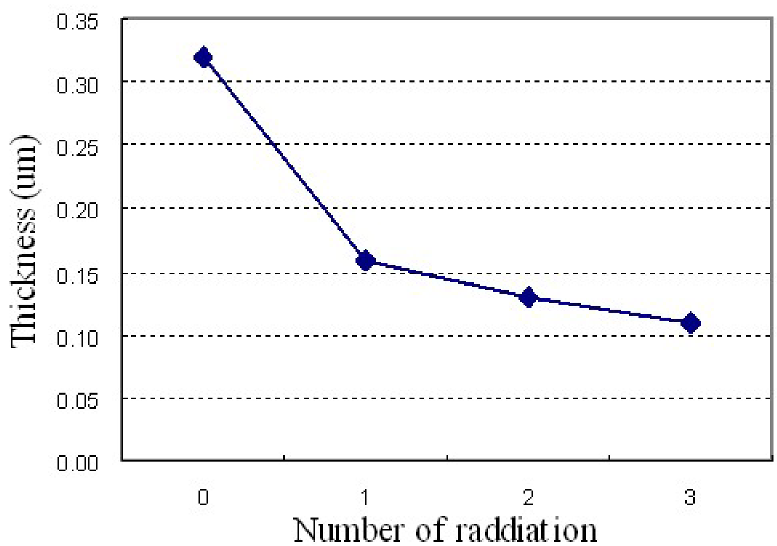

Figure 7 – Plasma Irradiation vs. OSP Thickness

Copper Oxidation after Heating

Amount of copper oxidation (Cu_2O) was compared by the peak height at certain wavelengths (approx. 640 cm^{-1}) with FT-IR as shown in Figure 8. Longer heat treatment times will accelerate the oxidation of copper. Thicker coatings tend to minimize the oxidation as shown in Figure 9. However, OSP-A, newly designed for BGA substrate applications minimizes the copper oxidation significantly in comparison with OSP-B and C, which are widely used formulations as OSP's for printed wiring boards. This result leads to better solder ball spreadability as well as higher solder joint strength afterward.

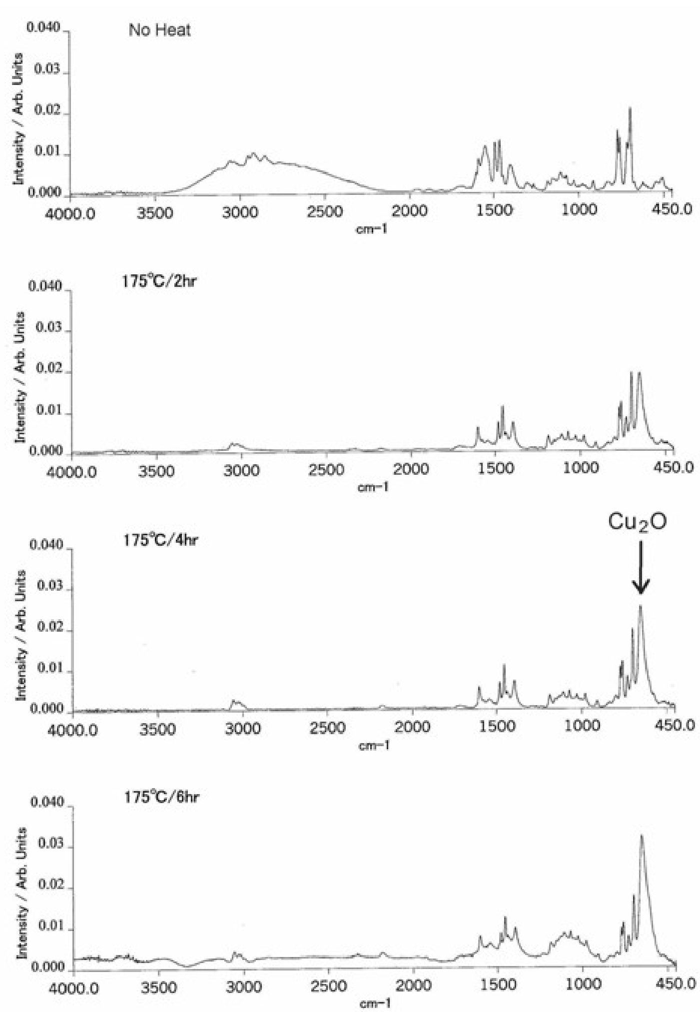

Figure 8 – Copper Oxidation after Heating

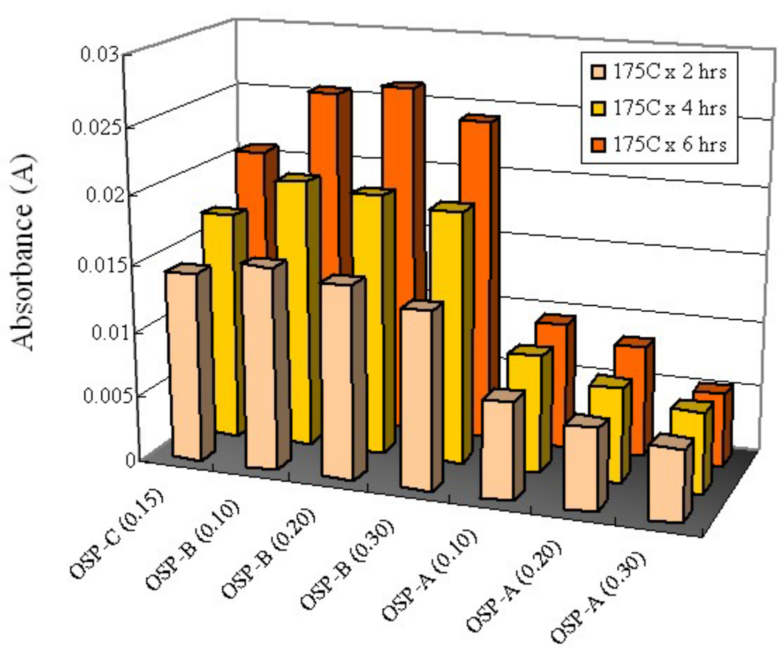

Figure 9 – Copper Oxidation after Heating

Solder Ball Spreadability

The solder spreadability was compared between two different OSPs with different thicknesses, Immersion silver and ENIG with/without 175 °C x 5 hours heat conditions as shown in Figure 10. Both of OSP-A and B shows the best spreadability without heating in conjunction with conventional tin lead solder. OSP-A shows better spreadability than OSP-B with heating. These results should be much related to the copper oxidation as Figure 8. Lead-free solder shows less spreadability in general, while no significant difference with heating.

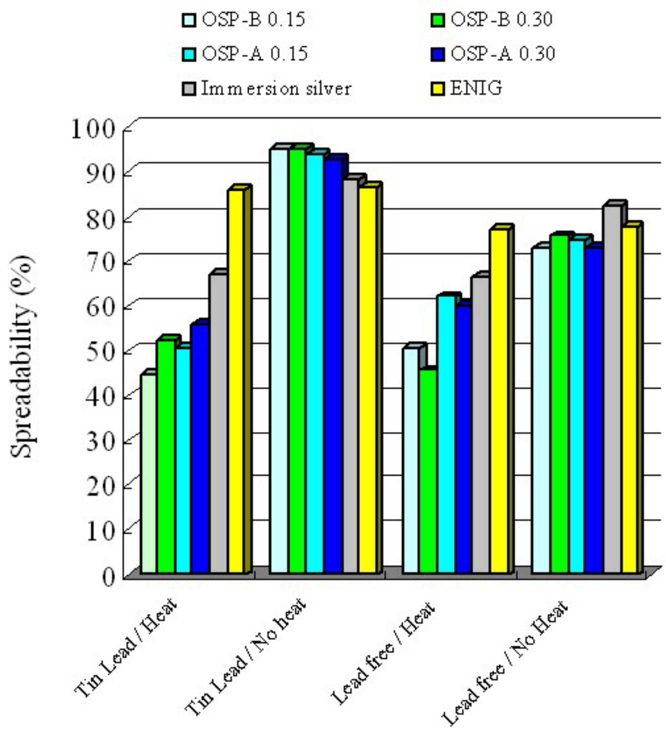

Figure 10 – Comparison of Different Materials and Surface Finishes

Solder Ball Pull Strength

This is one of the most important factors when determining the best surface finish for BGA substrate. The solder ball pull strength was compared between two different OSP with different thicknesses, Immersion silver and ENIG with/without 175 °C x 5 hours heat conditions as Figure 11a and 11b, in conjunction with conventional Tin-lead solder and Lead-free solder.

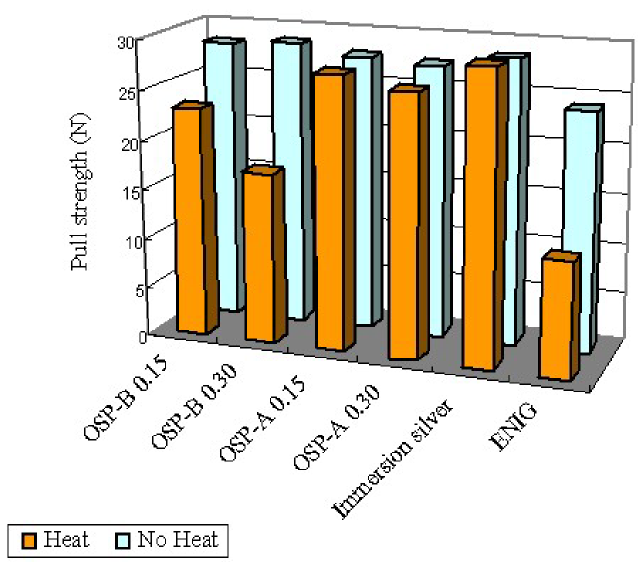

Figure 11a – Solder Pull Strength of Tin Lead Solder

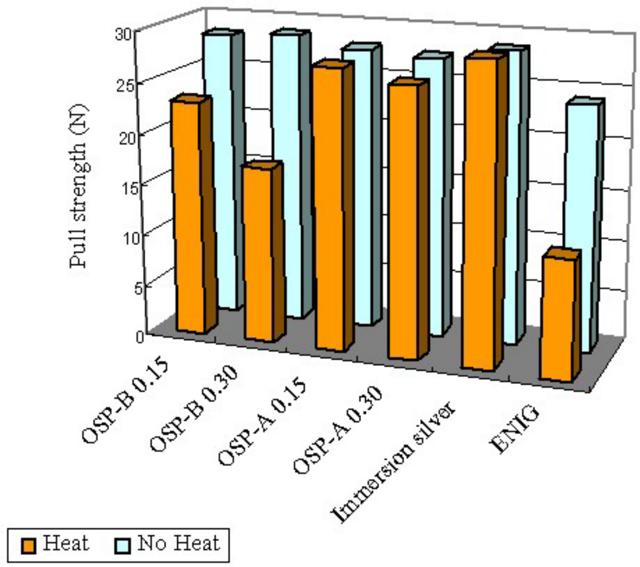

Figure 11b – Solder Pull Strength of Lead-Free solder

Tin-lead solder

The surface finishes expect ENIG shows excellent pull strength in case of no heating. Most of them are separated by solder itself, in spite of the intermetallic layer between gold and solder of ENIG. OSP-A shows better strength after heating compared with OSP-B, which should be related to the copper oxidation. ENIG shows much lower strength especially after heating. This it is believed, caused by the oxidation of the nickel underneath the gold deposit.

Lead-free solder

In the absence of a thermal excursion, most surface finishes show almost same, but slightly lower pull strength than Tin-lead solder. On the other hand, in case of heating, OSP-B with lead-free solder retains higher solder joint strength than tin-lead solder, while OSP-A and Immersion silver show slightly lower.

Conclusion

- ✓ The active ingredient is one of the most important ingredients of OSP to improve the heat-resistance, which becomes important much more in conjunction with lead-free solder. The latest OSP shows excellent stability even more than the peak temperature of reflow for lead-free solder.
- ✓ The heat conditions for BGA substrates due to adhesive and molding compound curing are significant when compared to standard pwb soldering conditions. In addition, BGA substrates typically under go a plasma irradiation prior to BGA placement and soldering. While the majority of OSP's based on alkyl-benzimidazole are unable to retain the solderability for lead-free soldering after these treatments, new generation aryl-phenylimidazole have been proven to resist oxidation and improve solder paste spreadability.
- ✓ Since plasma irradiation could remove the coating significantly, the coating should be controlled to a greater thickness. However, OSP designed for selective gold plating does not make any deposit on gold, and could achieve good wire bonding without plasma irradiation.
- ✓ OSP shows excellent solder pull strength especially in conjunction with tin-lead solder and lead-free solder, after heating, in comparison with ENIG. Performance against immersion silver is comparable.

Next Generation OSP for Lead-free soldering, Mixed Metal Finish PWB's and BGA Substrate

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SHIKOKU

Lead-free solder roadmap

(K.Suganuma, ISIR, Osaka Univ.)

	1998	1999	2000	2001	2002	2003	2004	2005-
Panasonic	MD	VTR	M/P		Domestic	Worldwide		
NEC	Pager	Note PC	Desktop PC		Domestic	Worldwide		
Hitachi		VCR	Note PC		Domestic		Worldwide	
SONY		Walkman	VCR Note PC	Domestic				Worldwide
Fujitsu			Server	Note PC M/P		Worldwide		
Toshiba			VTR	Note PC			Worldwide	
Epson				Printer Projector	Worldwide			
JVC				DVC				
Pioneer			DVD Car audio			Worldwide		
Casio				Calculator			Worldwide	
Nissan			Key		Worldwide			

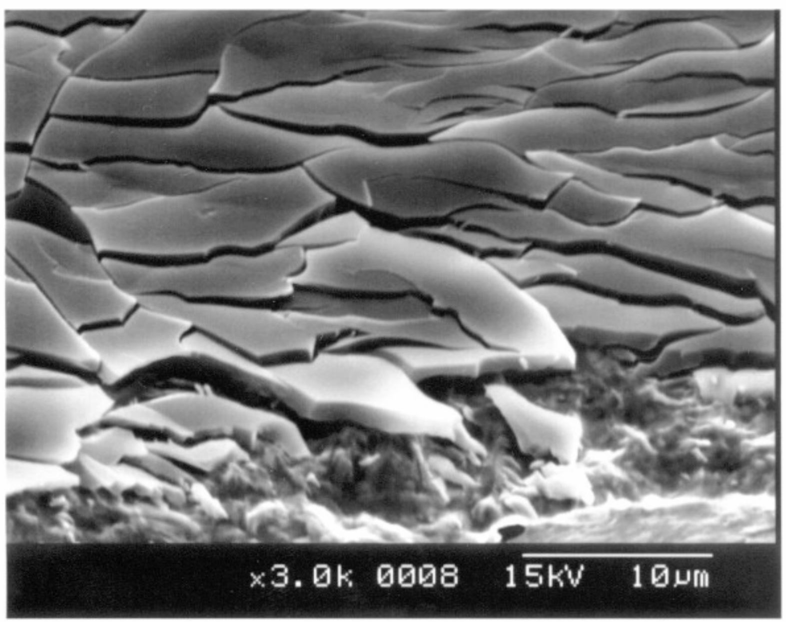
Solders used by Area of Industry served *(IPC 4th Draft)*

- SnAgCu is the most popular formulation in Japan, and lots of experience already in the market in conjunction with OSP.

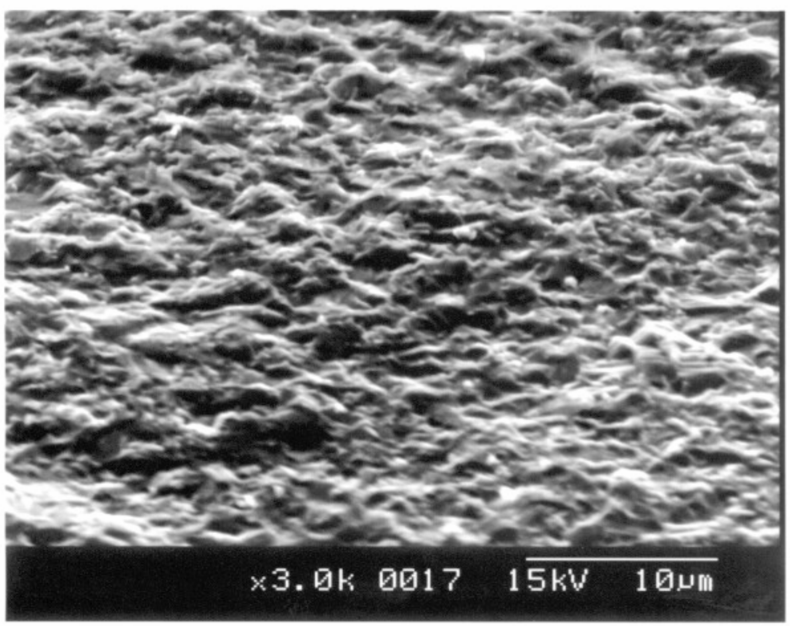
Solder	Melting Range (°C)	Industry served	Company
Sn Ag	221-226	Automotive	Visteon (Ford)
Sn Ag Bi	206-213	Military/Aerospace	Panasonic
		Consumer	Hitachi
Sn Ag Bi Cu		Military/Aerospace	Panasonic
Sn Ag Bi Cu Ge		Consumer	SONY
Sn Ag Bi X	206-213	Consumer	Panasonic
Sn Ag Cu	217	Automotive	Panasonic
		Telecommunications	Nokia, Nortel, Panasonic, Toshiba
Sn Bi	138	Consumer	Panasonic
Sn Cu	227	Consumer	Panasonic
		Telecommunications	Nortel
Sn Zn	198.5	Consumer	NEC, Panasonic, Toshiba

OSP Coating

- Very thin (0.1-0.2 micron meter) and transparent organic coating.
- Uniform organic coating even in viahole easily by chemical reaction between active ingredient and copper.
- Excellent humidity resistance to protect copper oxidation for half to one year.



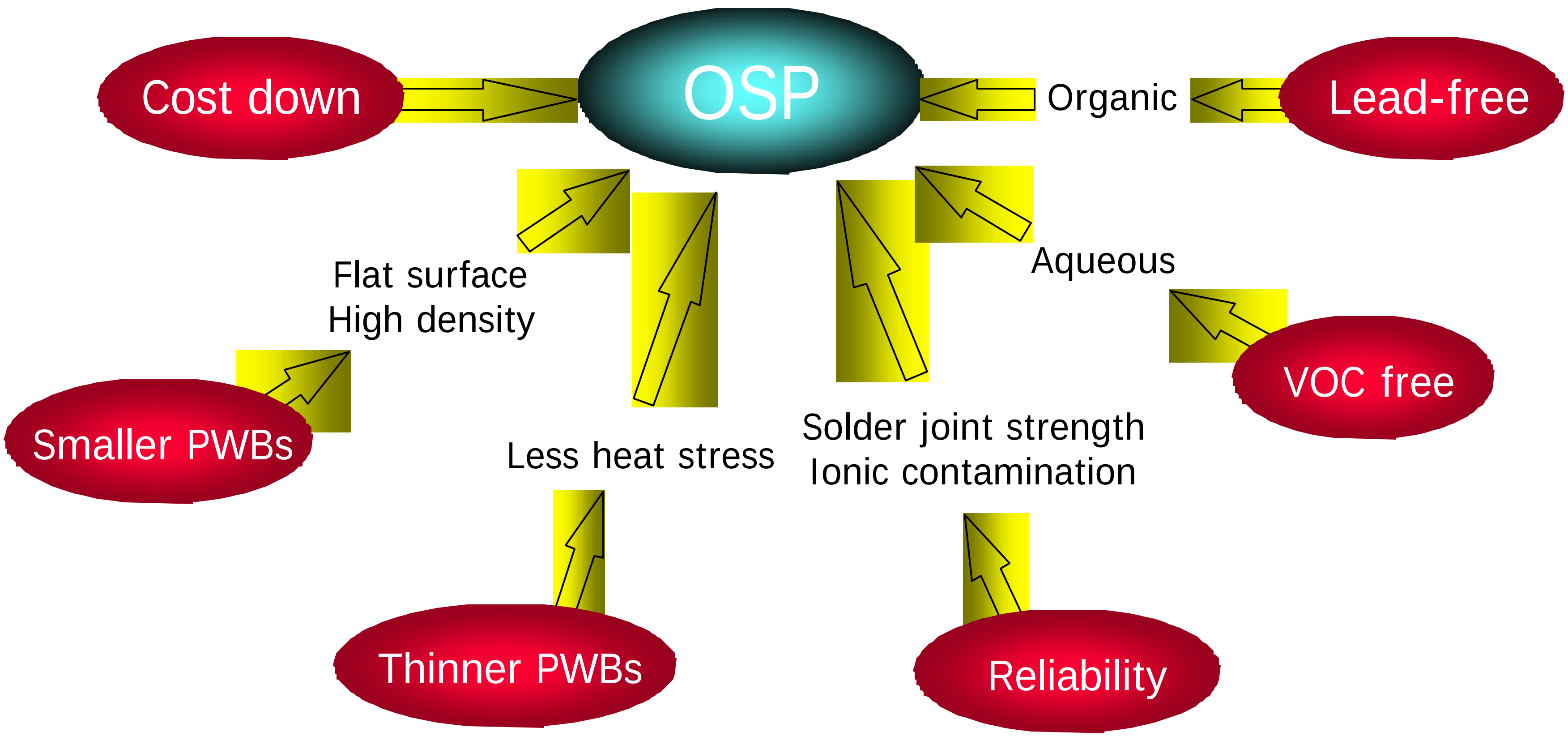
Too thick coating and broken by bending the laminate just for taking a photograph.



Normal condition

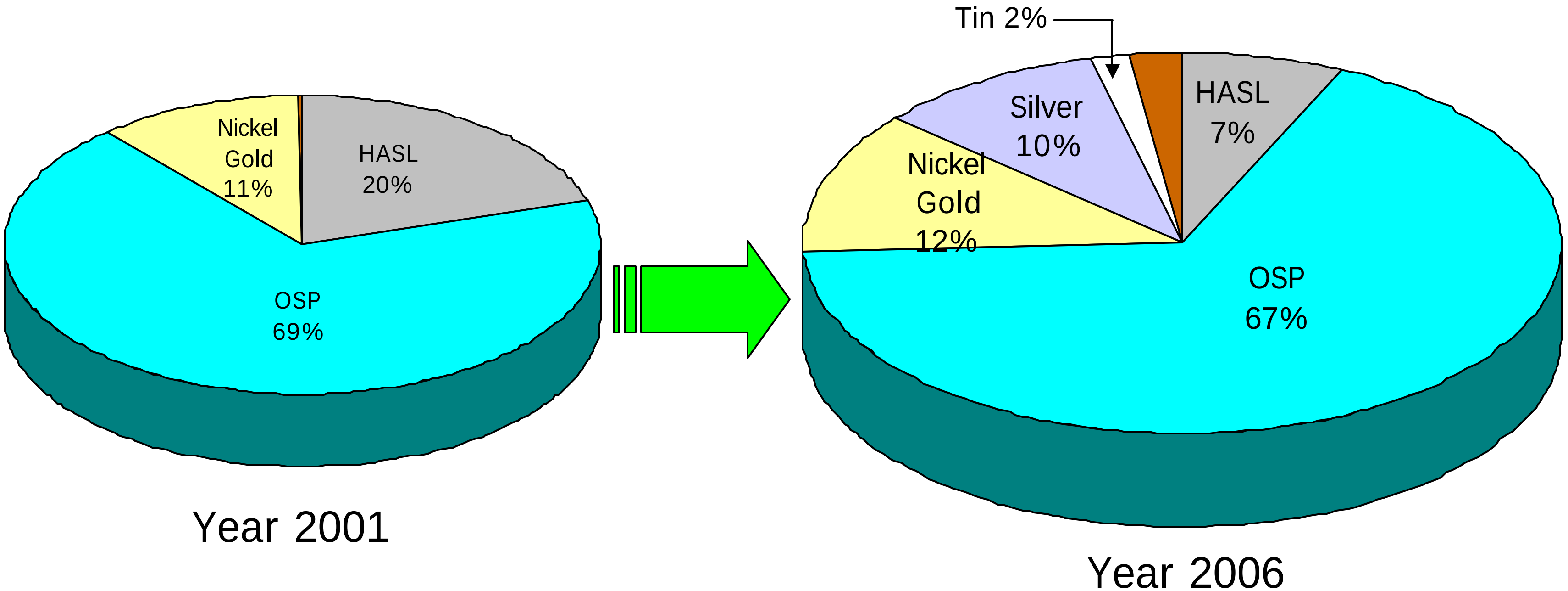
Why OSP?

- Lots of advantages covering variety of requirement in the market now and in the future.



Surface finish trend in Japan and Asia

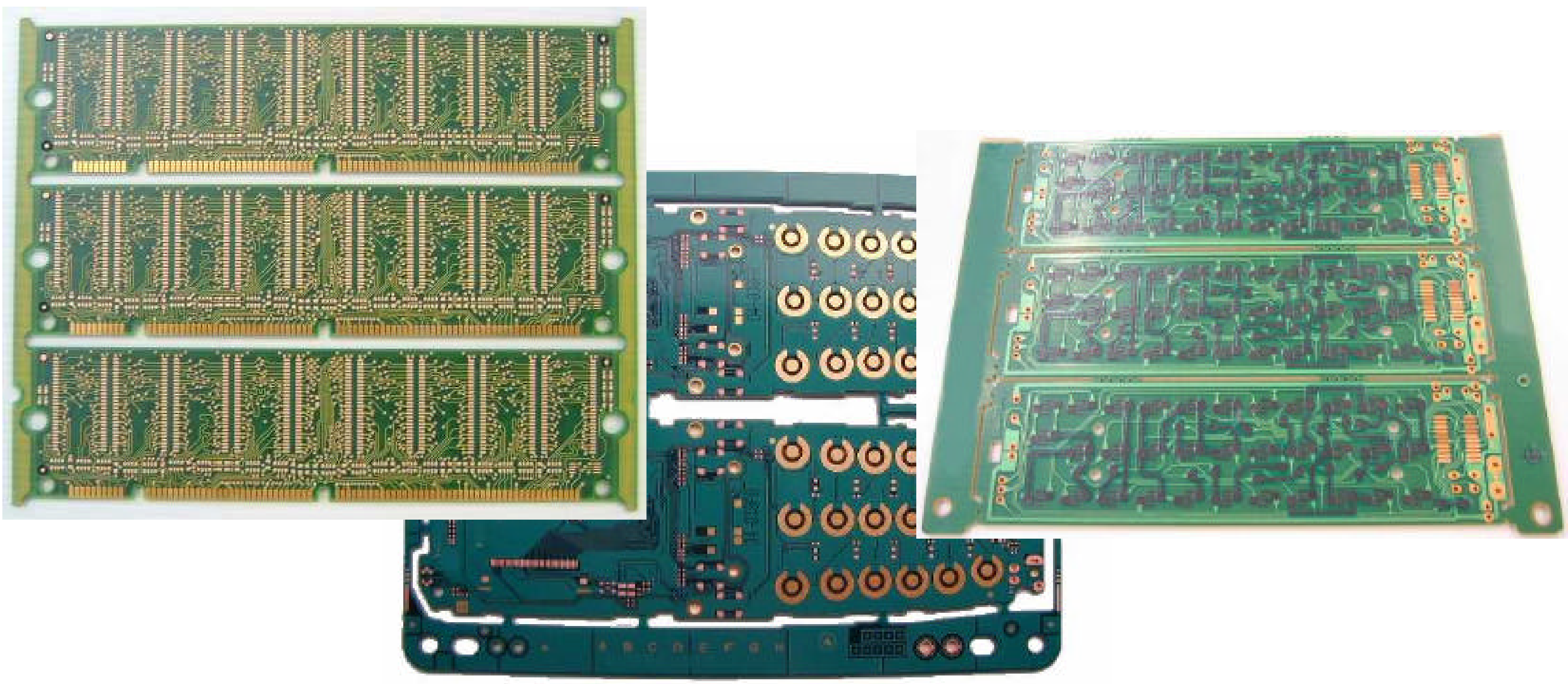
- OSP is the mainstream in conjunction with Lead-free solder.
- HASL is expected still lower, because of Lead-free restrictions.
- Total production in year 2006 is expected 30% higher than 2001 in Asia.
- Immersion silver is expected to replace a part of HASL.



(By Prismark partners)

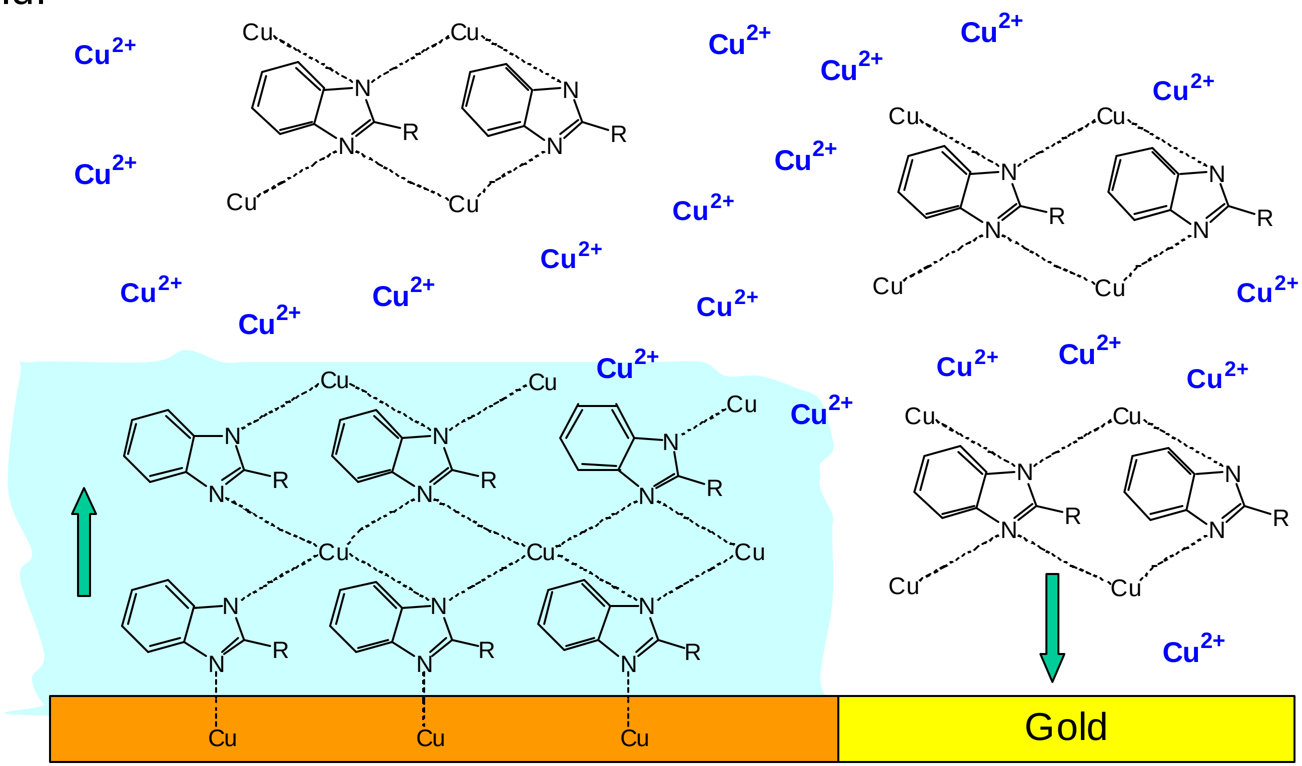
Selective gold

- More OSP and gold mixed PWBs in order to improve solder joint strength, but also good electrical contact.
- Similar requirement for IC package as well, and lots of evaluation in progress. However, the process is much different from normal PWBs.



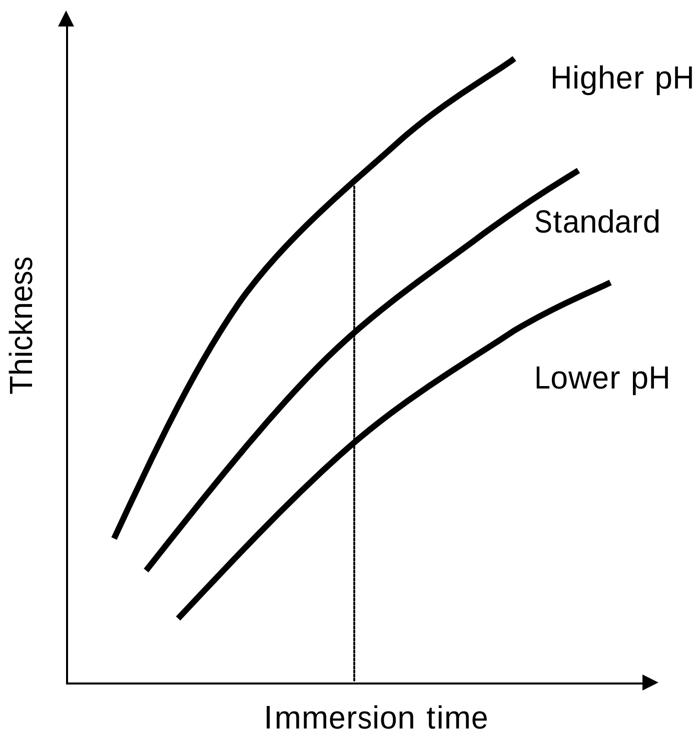
Selective gold

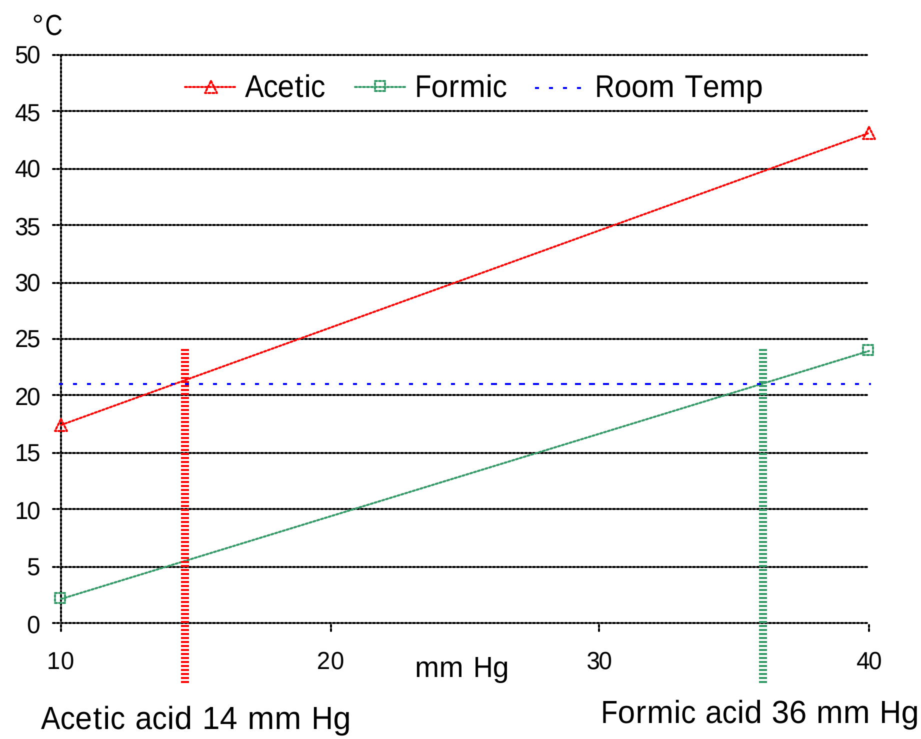
- Complex between imidazole and copper in the solution fall down on gold plating without mechanical bonding.
- Minimize free copper ion in the solution to prevent the deposit of complex on gold.



Process control / pH

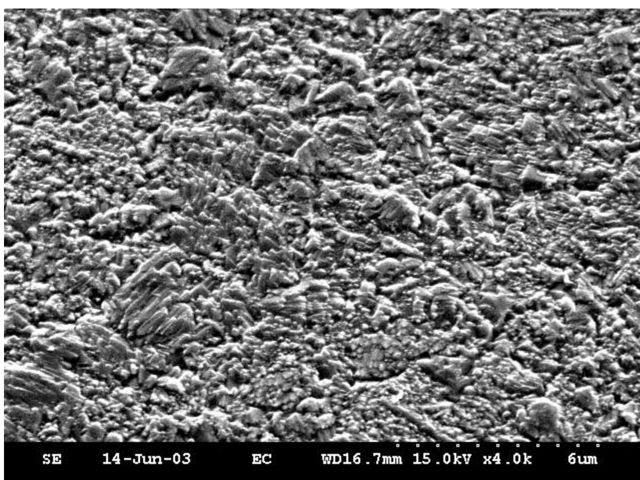
- Control the thickness within the optimum range is the most important finally. Too thin coating can not prevent copper oxidation during reflow, however too thick coating could be a barrier for soldering.
- pH is the most important factor to control within the range constantly.



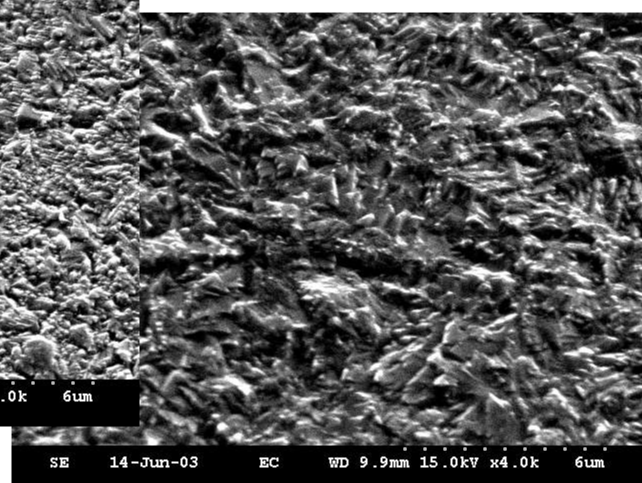


Process control / Microetching

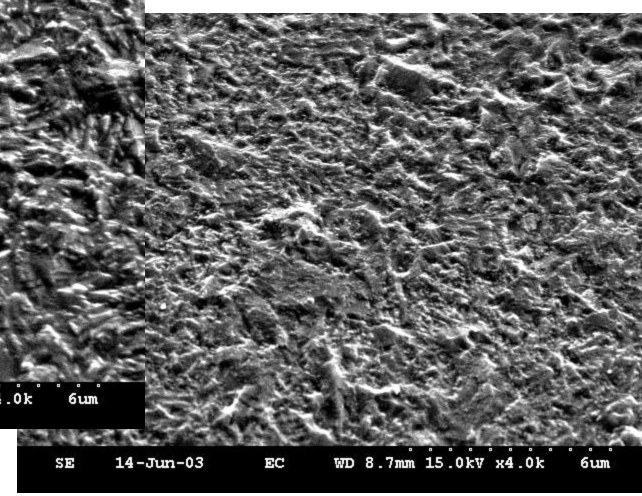
- Three major chemistry, Hydrogen peroxide, Sodium persulfate and Potassium persulfate.
- Each chemistry gives different appearance and properties.
- No anti-tarnish ingredient is recommendable.
- Hydrogen peroxide is the most popular in Asia and considered best to improve properties of OSP.



Hydrogen peroxide



Potassium persulfate

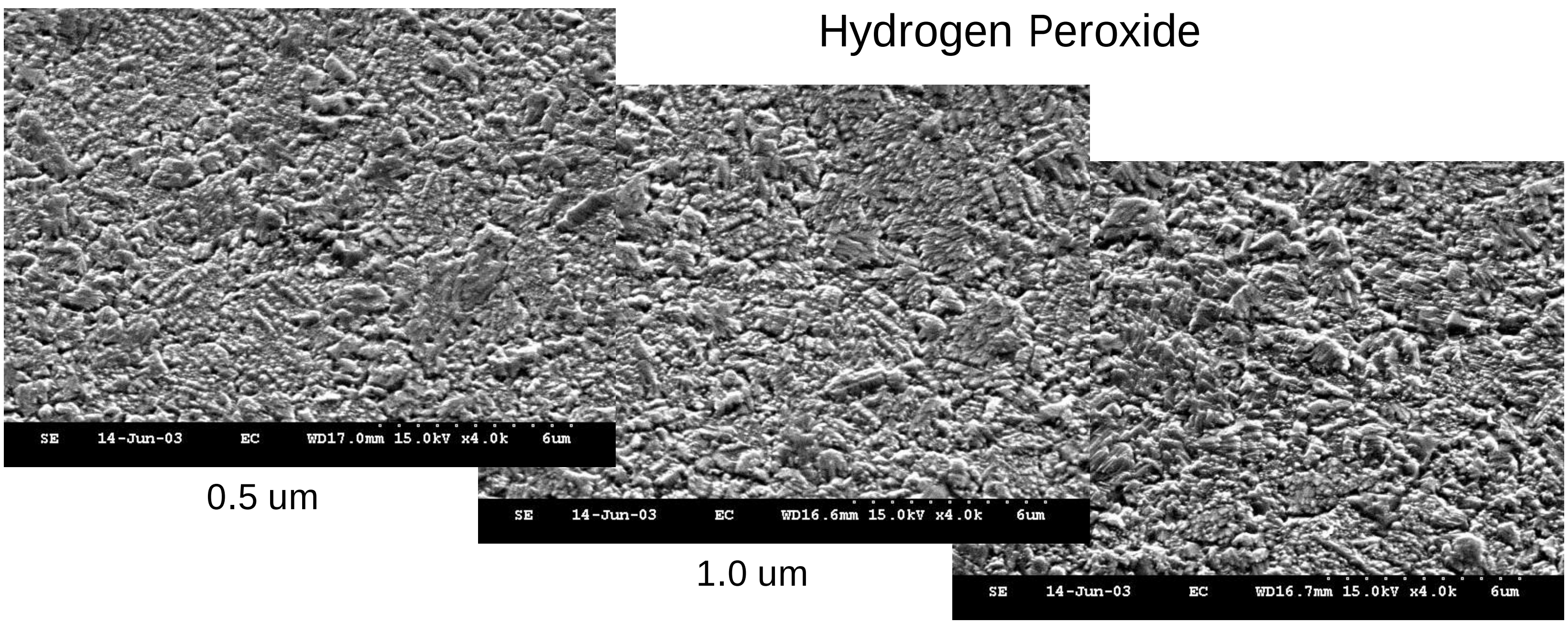


Sodium persulfate

Process control / Microetching

- Copper surface topography is the key to improve the properties of OSP.
- Appearance related to the topography and reflection index, not OSP.
- Important to keep sufficient etch rate, 1.0 um or more, in order to remove copper oxidation and scratch mark by brushing, etc.

Hydrogen Peroxide



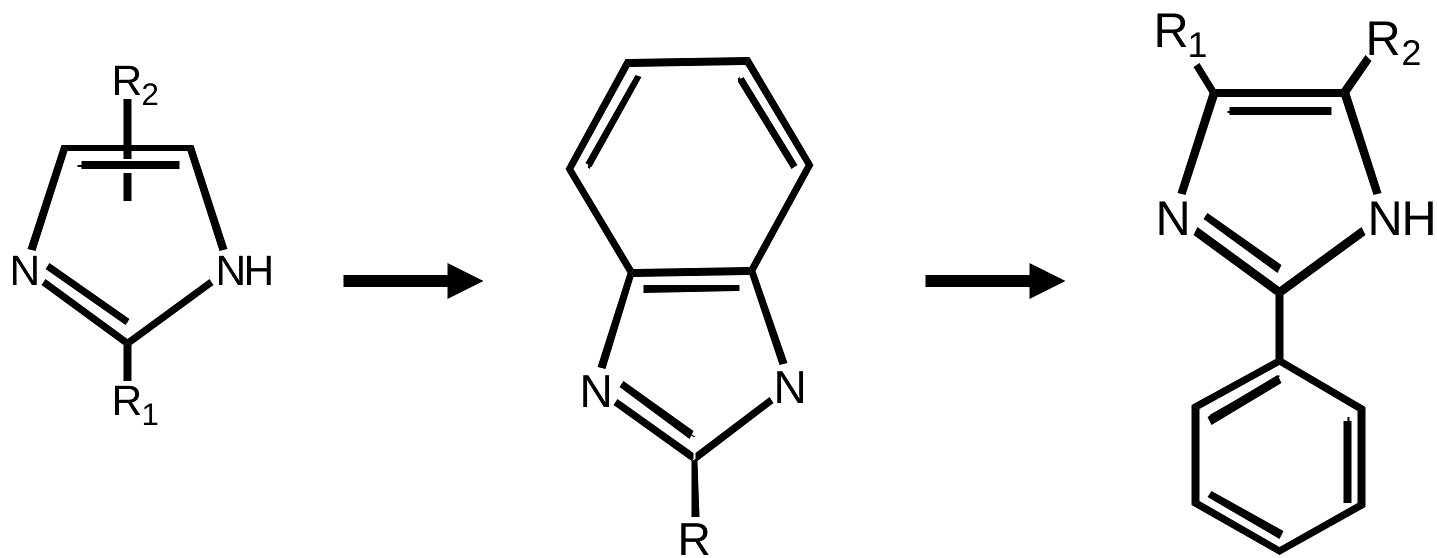
0.5 um

1.0 um

1.5 um

Innovation of Active ingredient

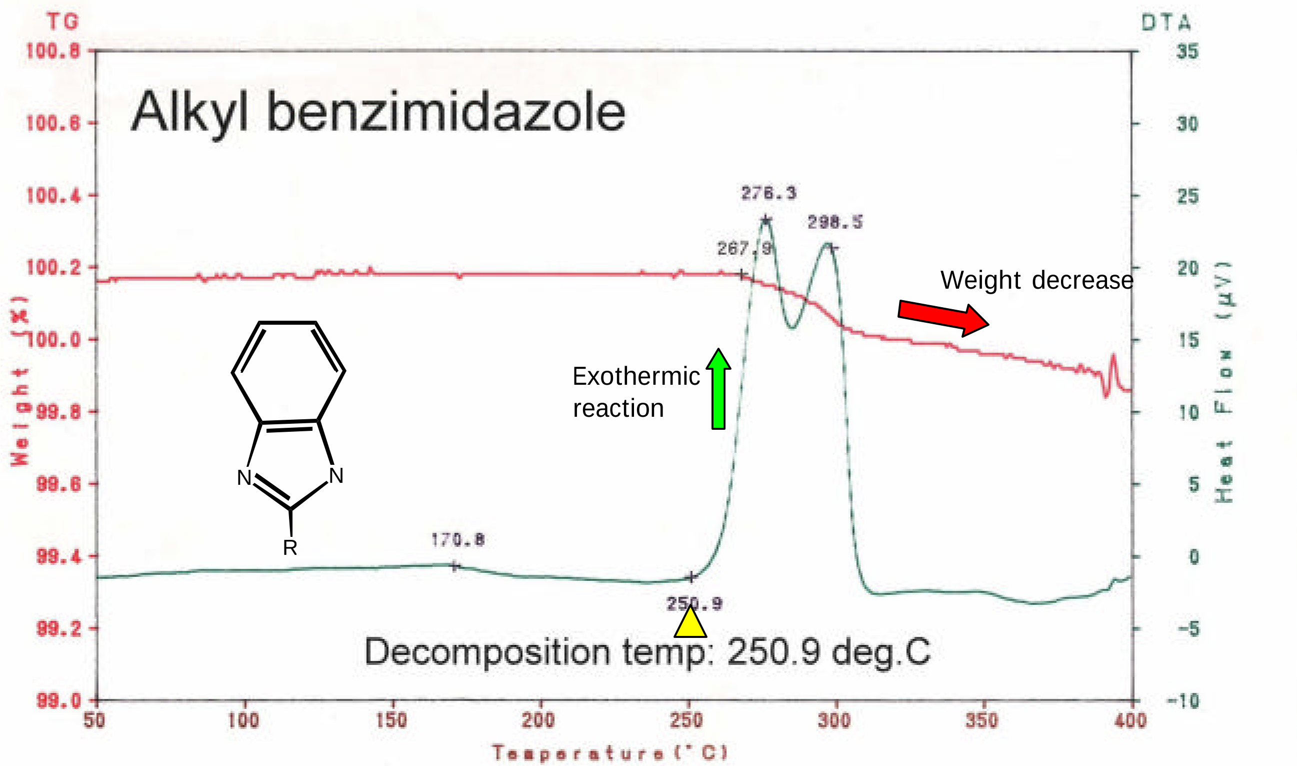
- Key to improve the properties of OSP.
- Developing new derivatives continuously, but same mechanism with copper.
- Widely used as an accelerator for epoxy compound to improve heat resistance like OSP.



Alkylimidazole   Alkyl benzimidazole   Aryl phenylimidazole

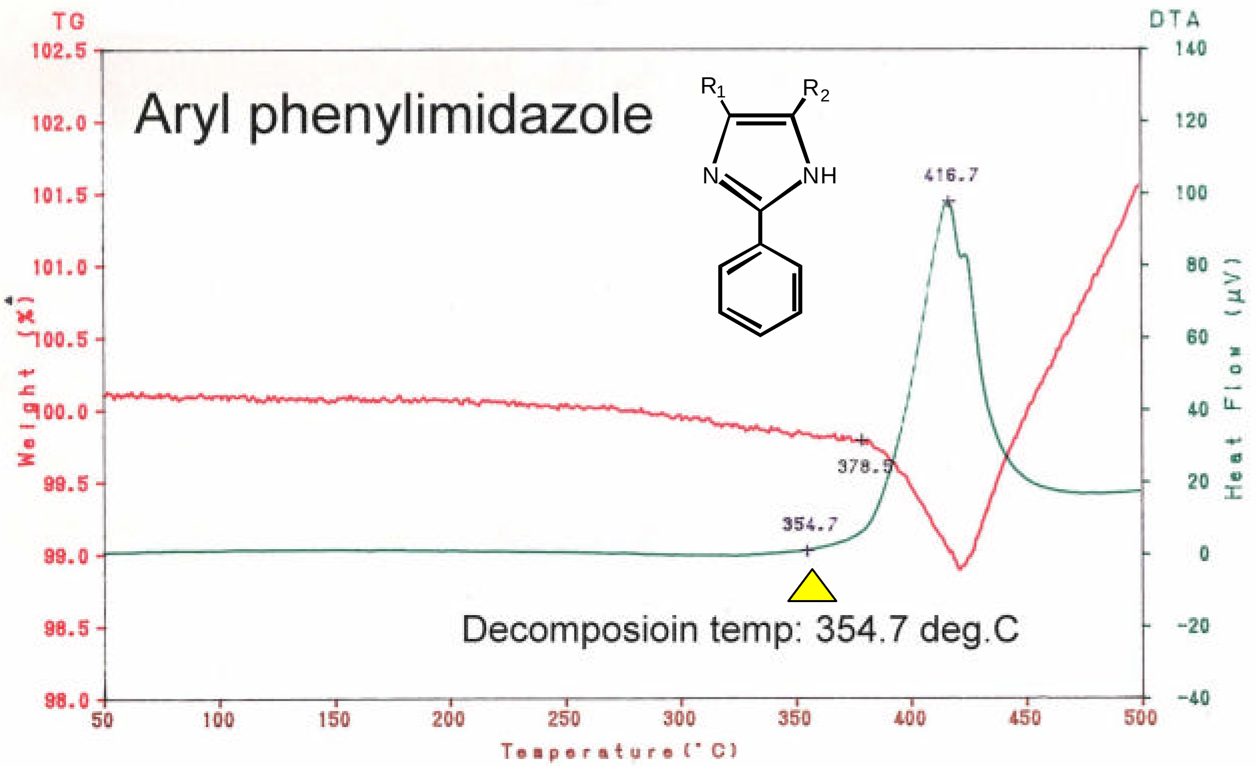
Heat resistance / TG-DTA

- Heat resistance of OSP coating itself is compared by using TG-DTA (Thermogravimetry - Differential Thermal Analysis).
- Alkyl benzimidazole shows almost same decomposition temperature as reflow peak temperature 250°C for Lead-free solder.



Heat resistance / TG-DTA

- Aryl phenylimidazole shows much higher decomposition temperature than the other OSPs and reflow peak temperature for Lead-free solder.
- The chemical structure of imidazole is important to improve Tg (Glass transition temperature) of epoxy resin as a hardener.



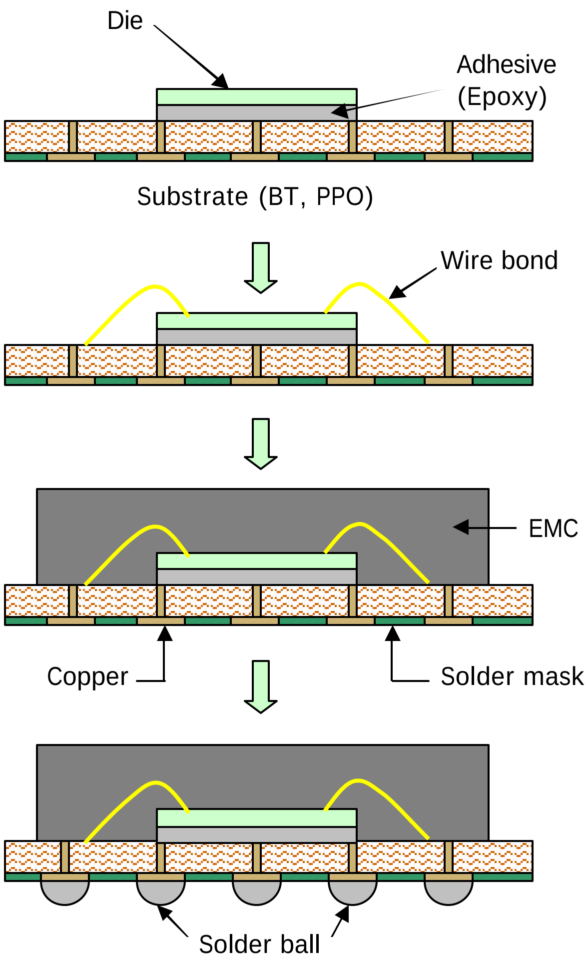
OSP for BGA substrate with Selective gold

- New potential application of OSP
- Gold surface on the top side for wire bonding, however copper and OSP for ball side, in order to improve the solder joint strength.
- No more gold surface is necessary for flip chip technology, because of no wire bonding

Assembling process of Die and Ball

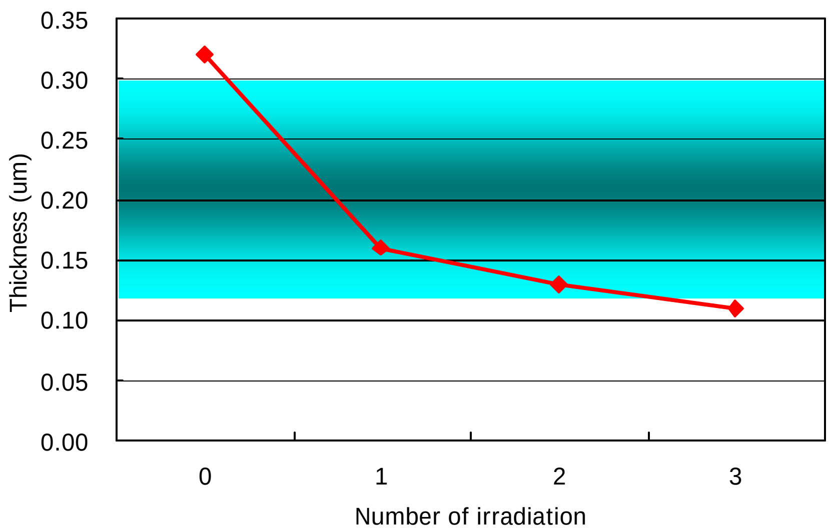
- Much longer heat stress compared with normal PWBs and unique plasma irradiation prior to ball mounting.

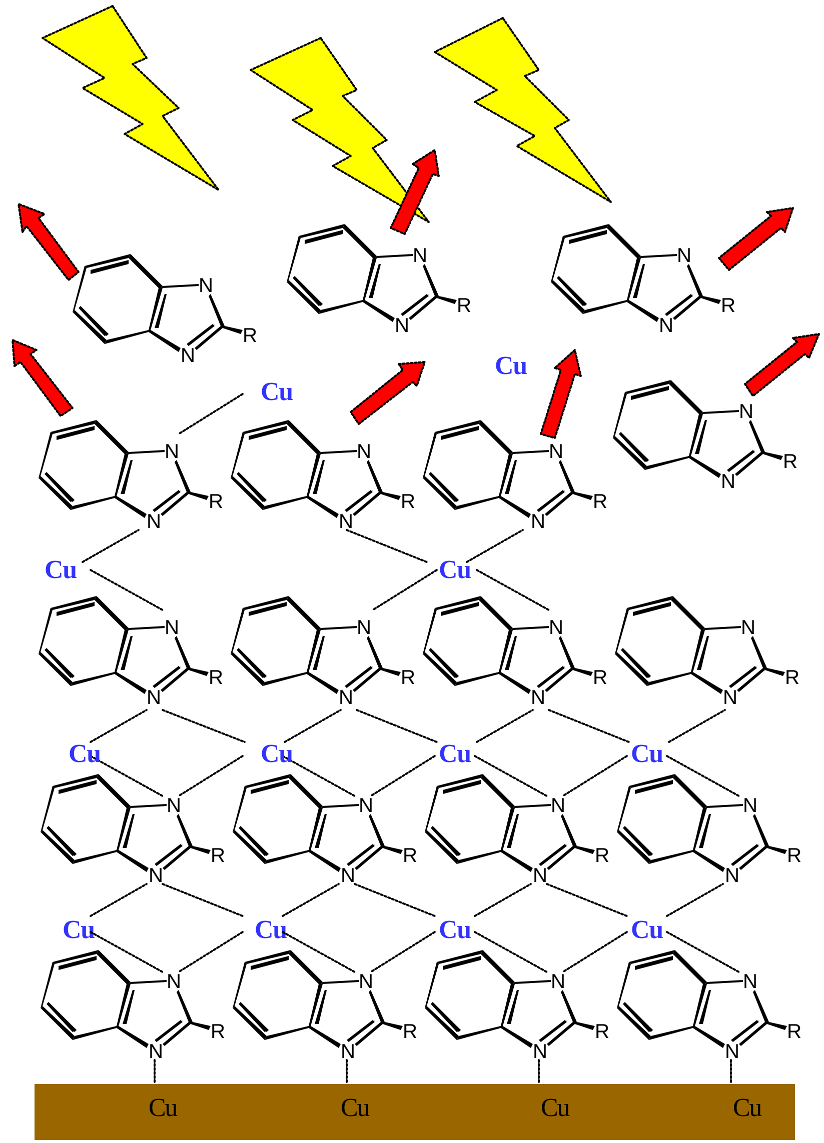
1. Baking the substrate to remove moisture at 120-130°C for a few hours.
2. Chip mounting and cure adhesive at 170-180°C for several minutes.
3. Plasma irradiation for several minutes to clean gold surface and make the solder mask surface rough to improve the adhesion of EMC (Epoxy Molding Compound).
4. Wire bonding
5. Pre-cure Epoxy Molding Compound
6. Post-cure EMC at 170-180°C for 4-6 hours under air.
7. Dip solder ball with flux and mount on the substrate followed by reflow.



Plasma irradiation

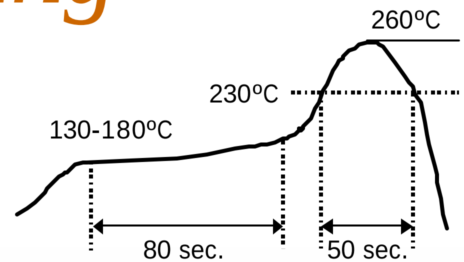
- OSP coating is decomposed and removed significantly by the first irradiation, however small reduction by the second and the third one.
- The polymerization on the surface should be weaker than the bottom, because of less density of copper ion probably.

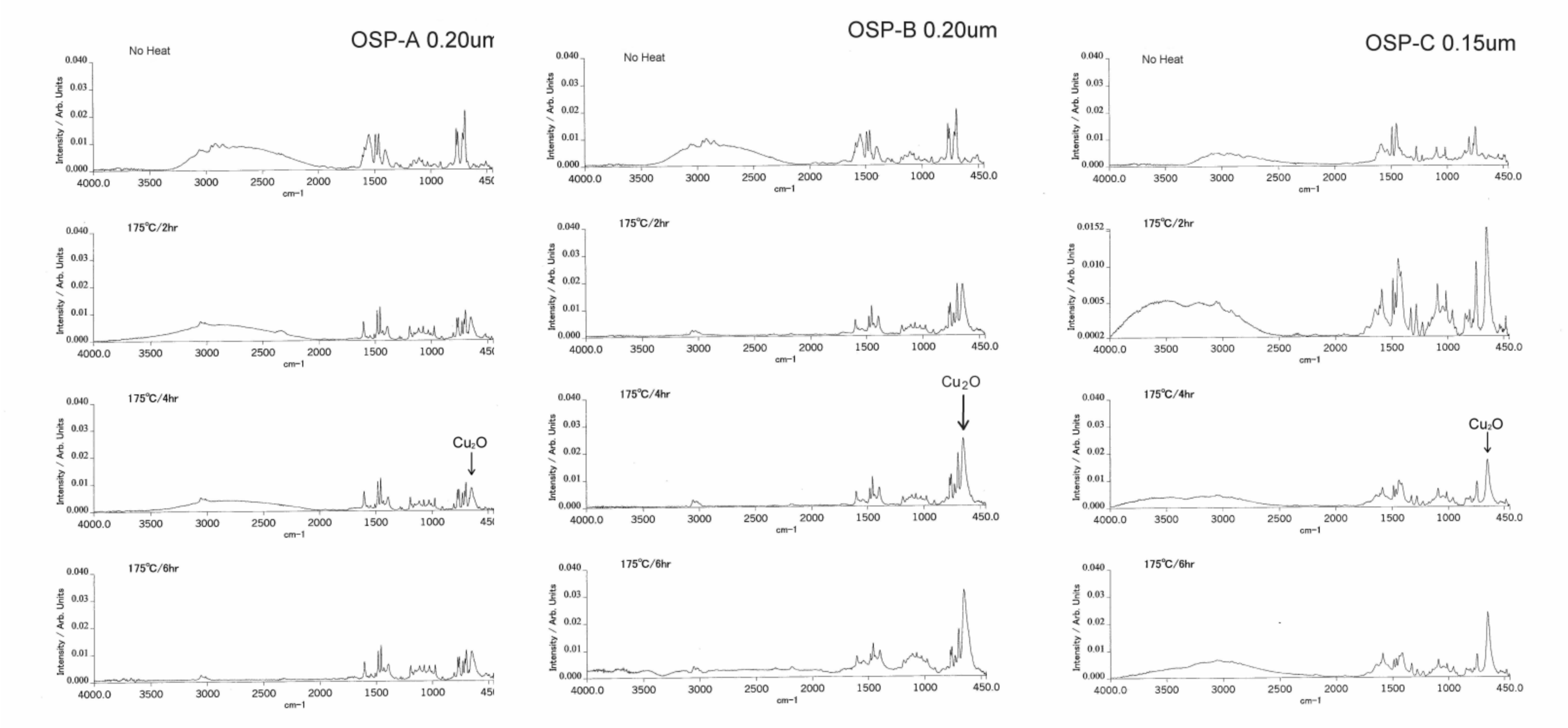




Copper oxidation after heating

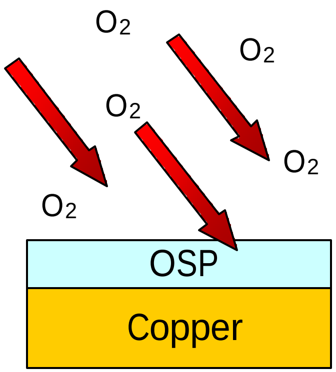
- Compare the peak of copper oxidation Cu_2O by FT-IR after 175°C for 2,4 and 6 hours heating under air.
- No copper oxidation is identified even after 5 times reflow used for normal PWBs.

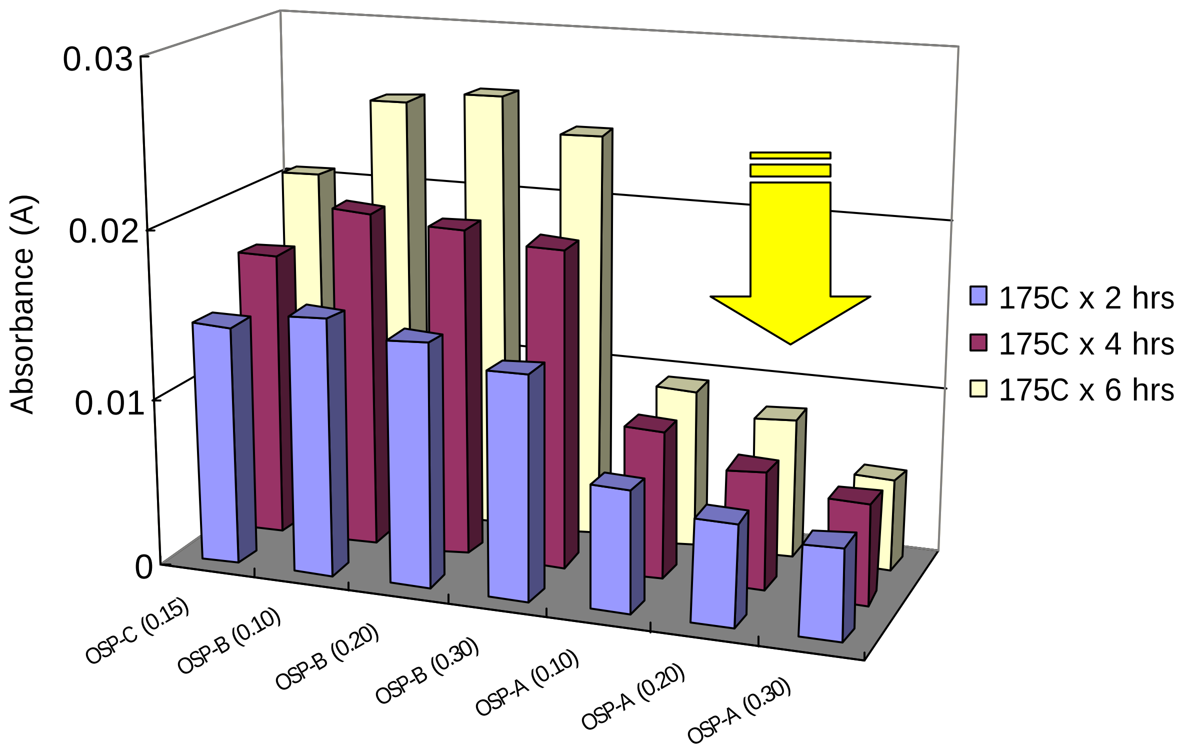




Copper oxidation after heating

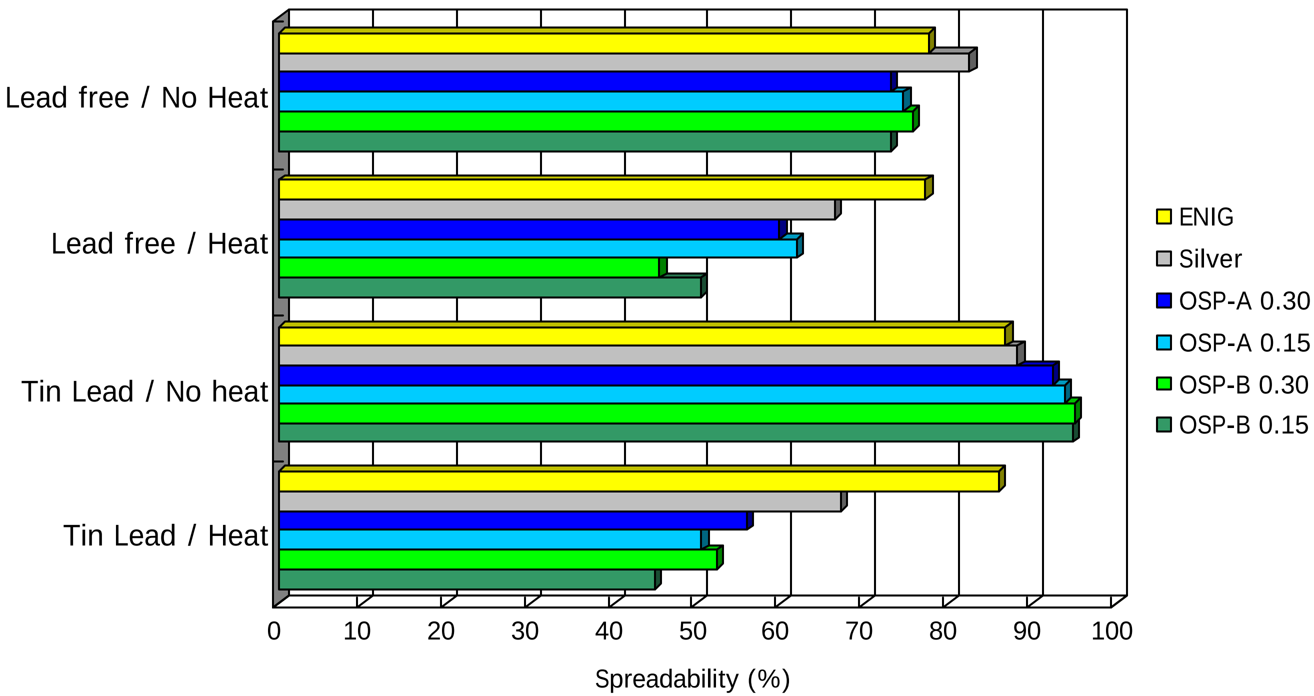
- OSP-A, the latest model designed for BGA substrate prevents copper oxidation significantly even after 6 hours heating.
- The thickness is also important to reduce the copper oxidation. Thicker coating is more effective in general.

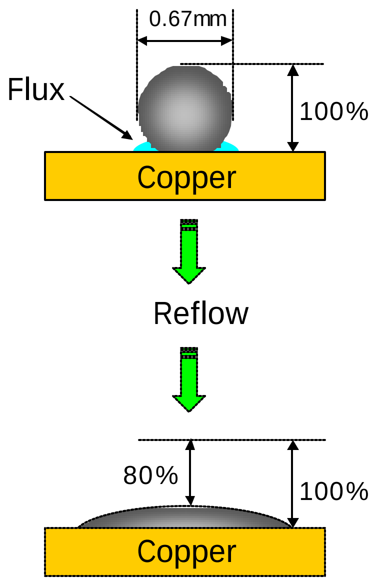




Solder paste spreadability *(JIS Z 3197)*

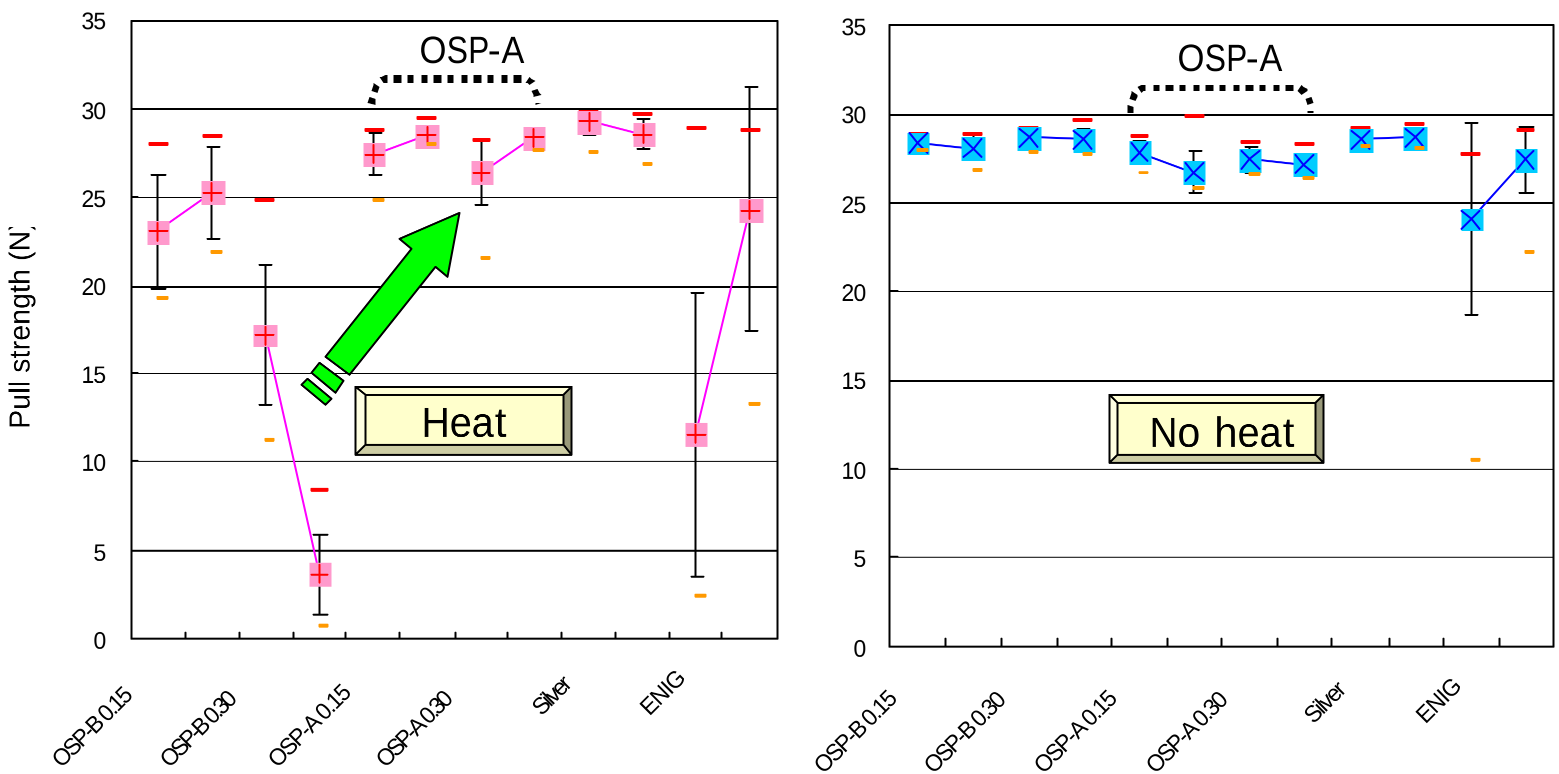
- OSP-A shows better spreadability than OSP-B after heating with Lead-free solder.
- OSP shows the best spreadability without heating, but much worse after heating. The heat condition 175°C x 5 hours is not comparable with normal reflow.
- The spreadability is not so critical for BGA, because of relatively bigger ball size for small pads.





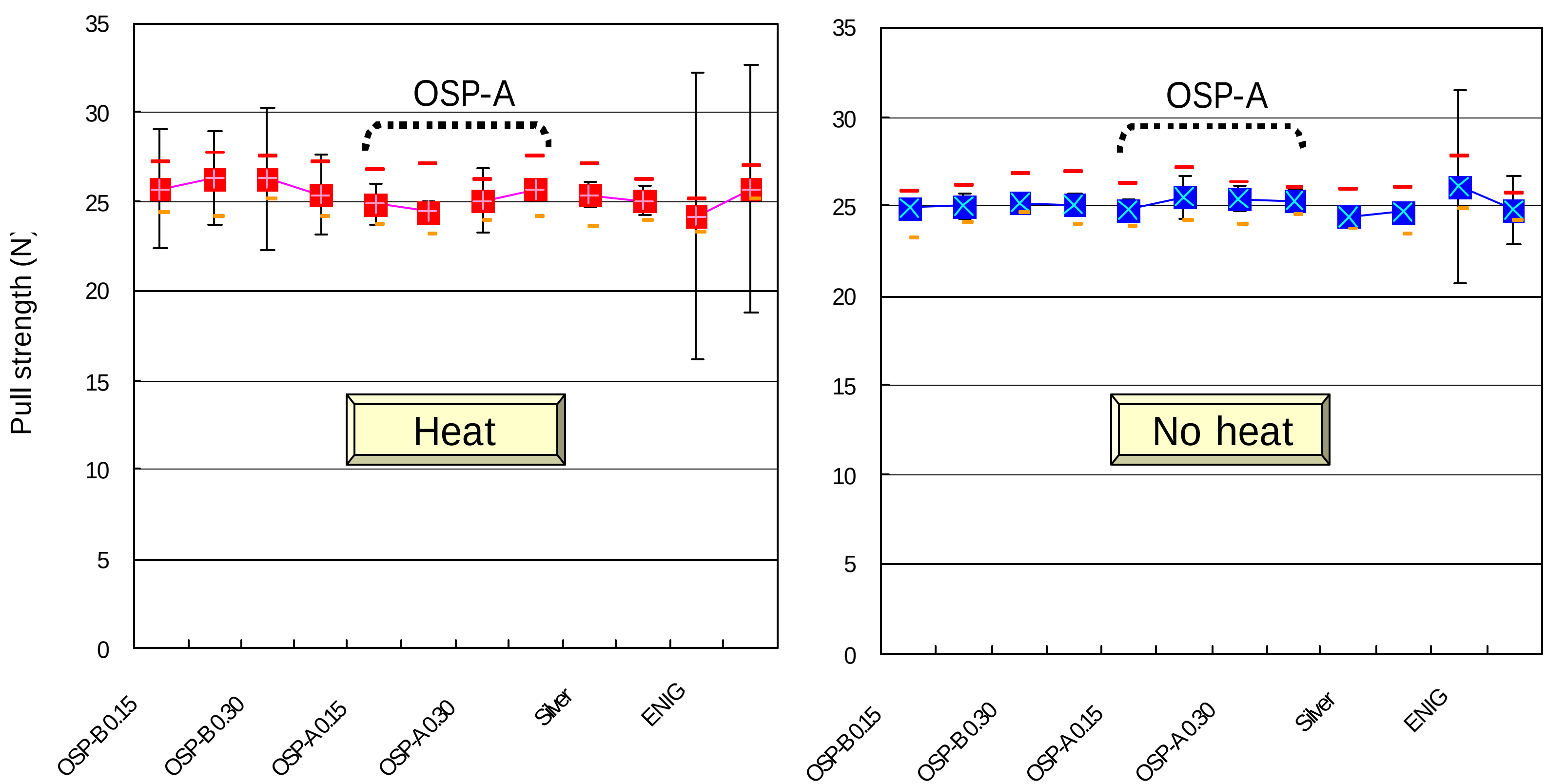
Pull strength / Tin Lead Solder

- OSP-A, the latest model designed for BGA shows excellent strength even after heating, 175°C x 5 hours, which must be related to less amount of copper oxidation.
- Immersion silver also shows good strength even after heating, because of good diffusion into solder.



Pull strength / Lead-free solder

- ENIG shows very low and instable strength, however it could be related to process control such as phosphorous and halogen content.
- No significant difference in average by surface finishes even after heating.



Solder joint / Void

- Test conditions

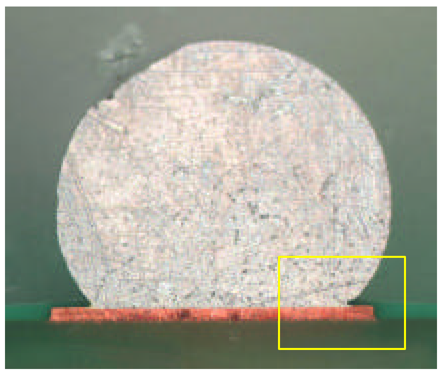
  TOSMICRON-7160FP (Toshiba IT Control System), 75kV, 70 uA
- Result

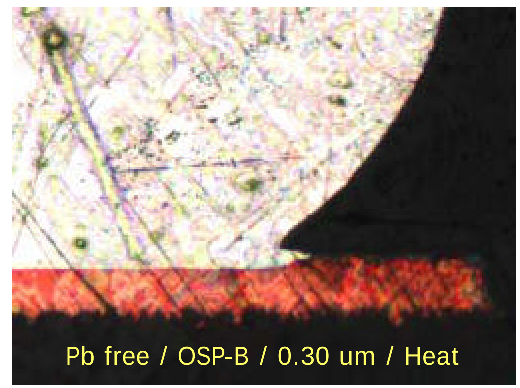
  No void observed with all copper surface finishes and solder
- Consideration
  - OSP thickness, thinner is better to reduce void?
  - Solder ball flux selection, water soluble or rosin type
  - Solder paste printing prior to solder ball mounting
  - Lead-free solder formulation, more void concern than Tin Lead solder

(X-ray photo)

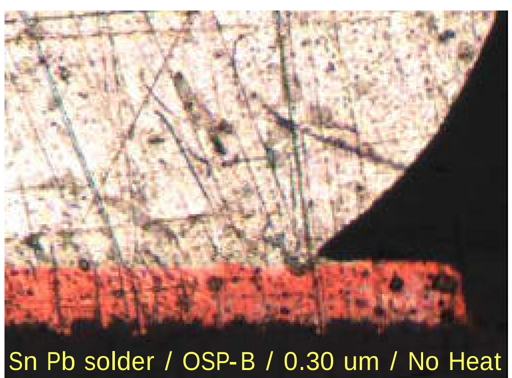
Solder joint / OSP

- Good solder joint by OSP, except OSP-B 0.30 um which shows solder/copper interface separation, because of high copper oxidation.
- More solder separation with Lead-free solder.
- Copper erosion by Lead-free solder.

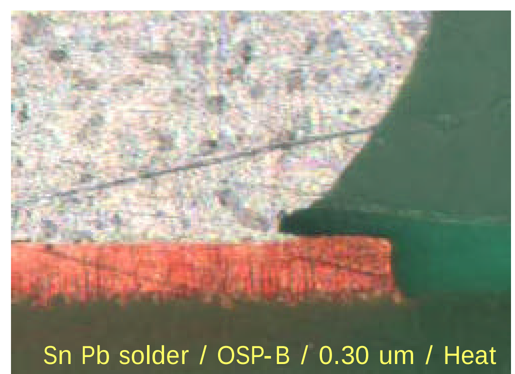




Pb free / OSP-B / 0.30 um / Heat



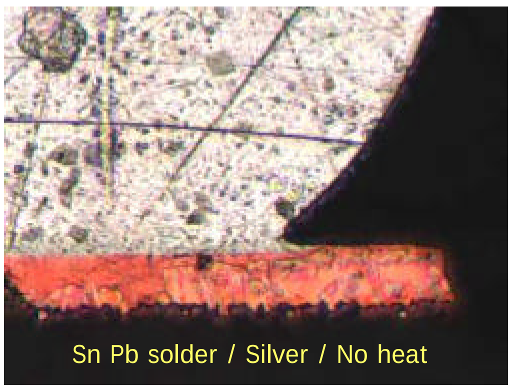
Sn Pb solder / OSP-B / 0.30 um / No Heat



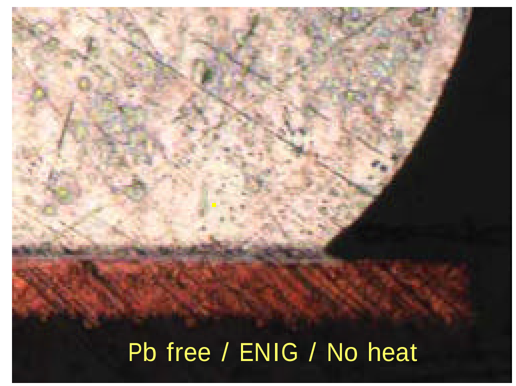
Sn Pb solder / OSP-B / 0.30 um / Heat

Solder joint / Silver and ENIG

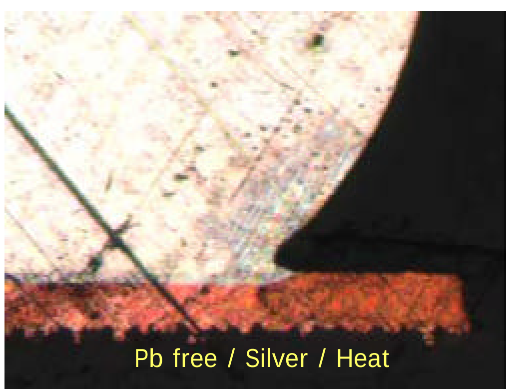
- Good solder joint by Silver, however lots of interface separation by ENIG, because of Nickel corrosion probably. The interface is discolored clearly.
- Small copper erosion by silver, but no erosion by ENIG with Lead-free solder.



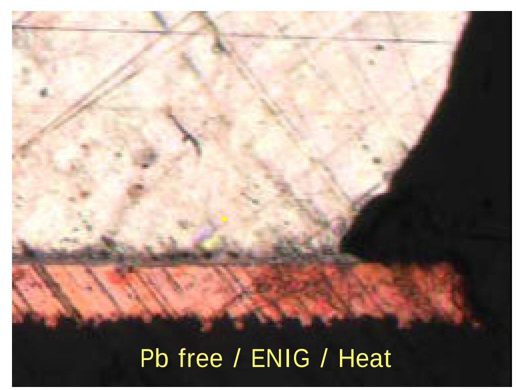
Sn Pb solder / Silver / No heat



Pb free / ENIG / No heat



Pb free / Silver / Heat



Pb free / ENIG / Heat

Conclusion

- Lots of experience of Lead-free solder in Asia already, and now in progress in Europe and the US as well. There are several option for copper surface finishes such as OSP, Silver, ENIG, Tin and Lead-free HASL, however OSP is the major stream in Asia so far.
- Continuous development of enhanced OSP with high heat resistance, good compatibility with Lead-free solder, easy to control the process, etc. It's very important to choose the best one all the time.
- More PWBs with selective gold such as Mobile phone, Memory module and BGA, which unique OSP is the most suitable finish without extra process to prevent deposit on gold.
- BGA substrate is new potential application of OSP. Although the heat condition is much harder than normal PWBs, the latest OSP gives satisfaction by minimizing copper oxidation.

Thank you!

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