

Technical Services and SMT Knowhow Database of Nihon Superior

Wayne NG, NSJ Mar 07, 2018







Agenda

- Who are we?
- Who are our technical partners?
- What can we offer besides soldering material?
- SMT knowhow



Head Office: Osaka, Japan







R&D Centre

Toyanaka Osaka Japan

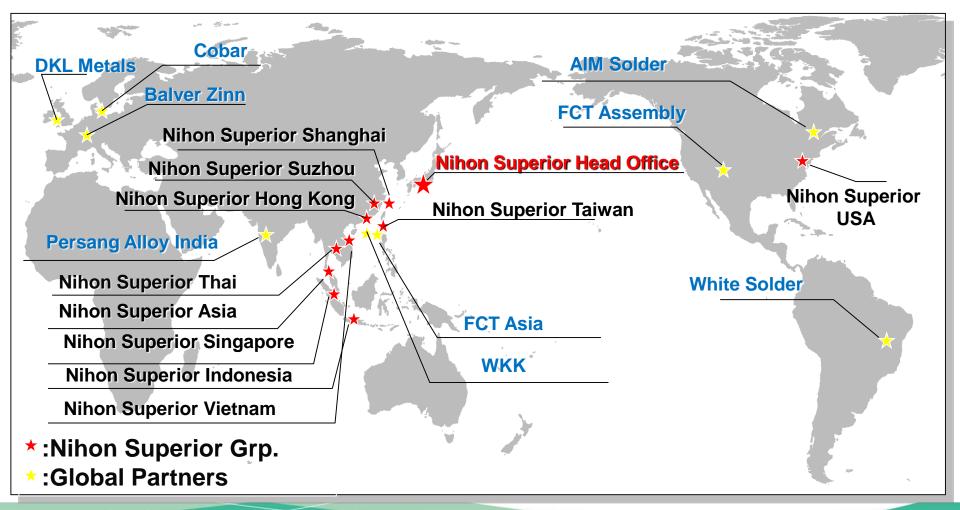




Covering the Global Market

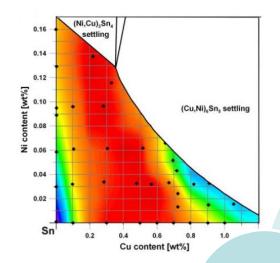
NS Offices

NS Licensees





Drawing on the expertise of top universities



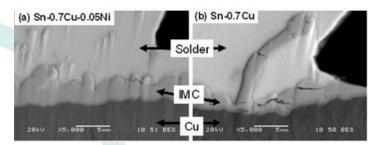
Imperial College London

Ni₃Sn₄ crystals

Ni substrate

College London University of Queensland





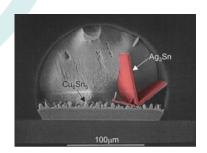
Funding various university projects to build strong foundation in interconnect

University of Malaysia Perlis



IOWA STATE UNIVERSITY

Iowa State University/
Purdue University











AREA Consortium









Memberships

- IPC
- iNEMI (International Electronics Manufacturing Initiative)
- Universal's Advanced Research in Electronics Assembly (AREA) Consortium
- HDP UG (High Density Packaging User Group)
- Soldertec
- Participant in JG-PP/JCAA Pb-Free Solder Project
- Participant in NASA/DoD Pb-Free Solder Project
- Surface Mount Technology Association International
- SIMTech Drop Impact Consortium
- Japan Welding Engineering Society Research
- Japan Welding Society Microjoining Commission
- Reliability Engineering Association of Japan
- Japan Institute of Electronics Packaging

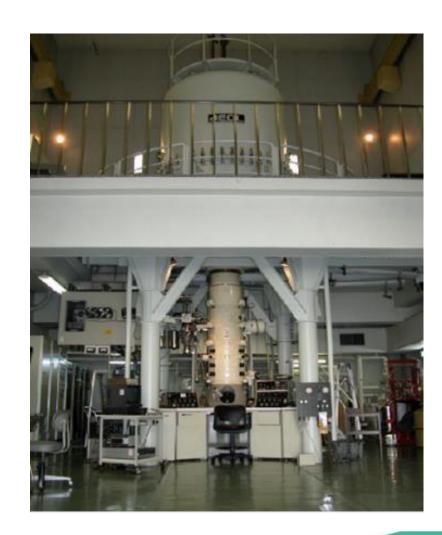


Access to State of Art Analysis Facilities Globally



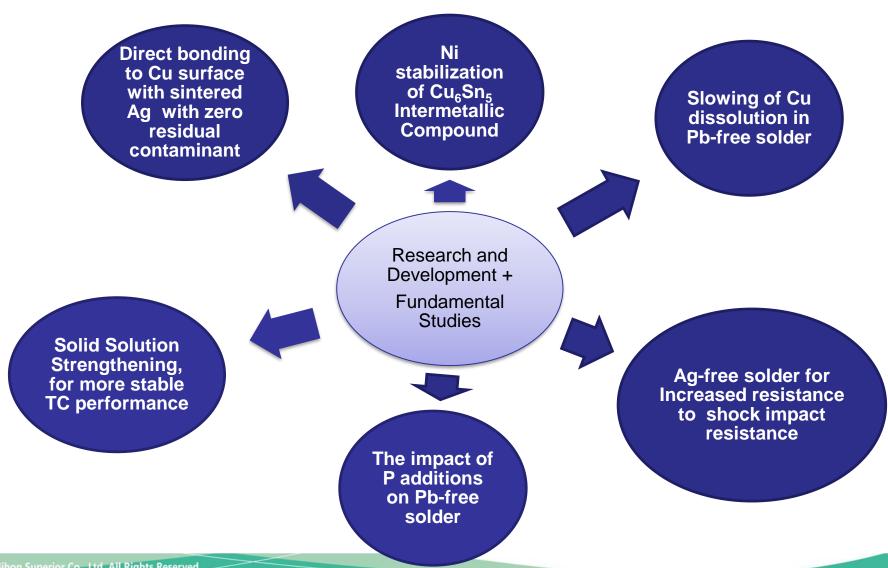


SPring-8 is a synchrotron radiation facility located in Hyōgo Prefecture





Contributions to Advances in Interconnect Technologies





Slowing of Cu dissolution in Pb-free solder

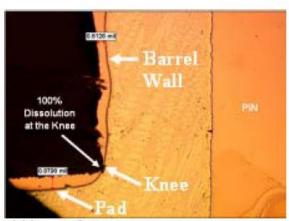


Figure 2. Hidden Defect

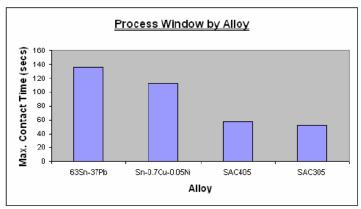


Figure 12. Process Window by Alloy

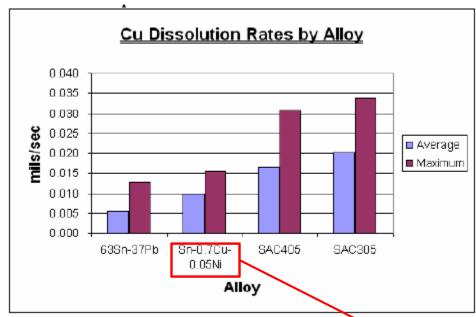
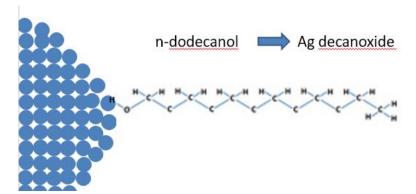


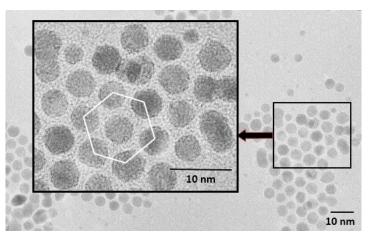
Figure 9. Dissolution Rates by Alloy

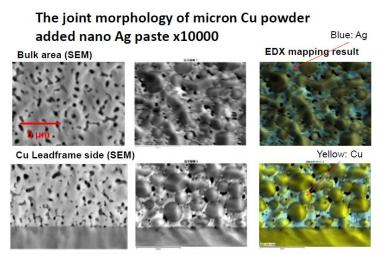
SN100C



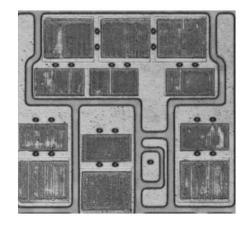
Direct bonding to Cu surface with sintered Ag with zero residual contaminants







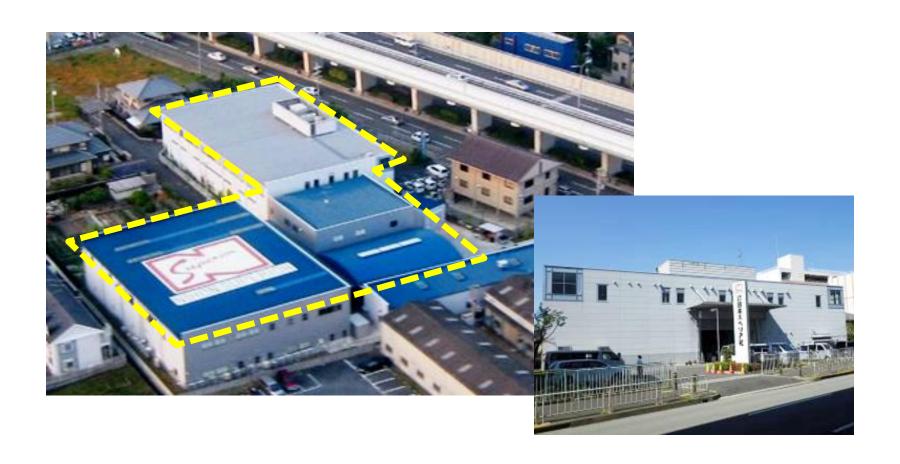
Micron Cu are dispersed within the sintered Ag matrix



Direct Bonded Copper (DBC) substrate



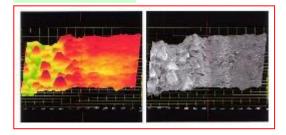
NSJ R&D Toyanaka Osaka Japan



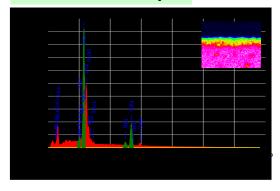


NSJ R&D Technical Services

3D Observation



EDX Element Analysis

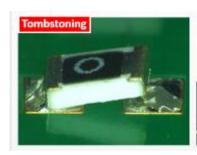






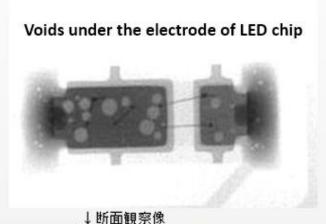
NSJ R&D Technical Services

Failure analysis





X-ray Analysis / Voids and Mid-chip Balls



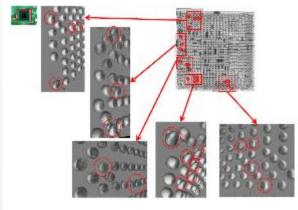


Balls under chip capacitor











Total Customer Support

Nihon Superior offers technical support for the introduction of new materials and optimization of lead-free soldering processes.



Support for Your Production

Atomic Absorption Spectrometer



X-Ray Fluorescence Spectrometer



Optical Emission
Spectrometer
Diagnostic Testing



ICP

Support for New Material Introduction

Reflow Soldering Machine



Wave-Soldering Machine



Selective Soldering Machine



Micro focus X-ray Testing System



SEM



Digital Microscope



Total Customer Support

Support for qualifying new materials

Wave Soldering



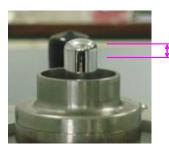
3 Zone PreheatCapable of achieving optimal board preheat temperatures



Wave-Soldering Machine



Selective Soldering



Height of solder jet flow

Good hole fill and fillet formation X-Y motion makes it possible to approach each joint from the optimum direction

Reflow Soldering



Reflow Soldering Machine

8 Heating Zones (5 Preheat Zones, 3 Reflow Zones)





Environmental Reliability Testing

Equipment for environmental and reliability testing

Environmental chambers for Surface Insulation Resistance and Electromigration Testing



Thermal Shock Chambers





NSM R&D Ipoh Perak Malaysia



- Support Malaysia Manufacturing
- ☐ Provide technical support to regional customers including
 Thailand and Vietnam
- ☐ Failure analysis for customer.
- ☐ Conduct training and seminar to local customers

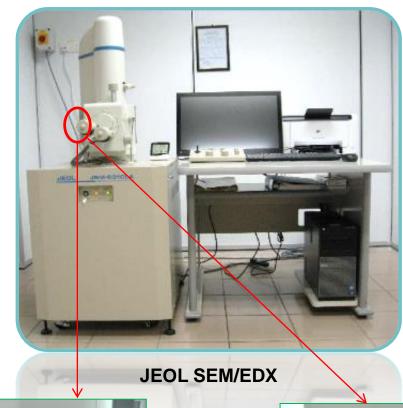




OLYMPUS Metallurgical Microscope



KEYENCE Digital Microscope





JEOL EDX System







SHIMADZU ICPS Emission Spectrometer



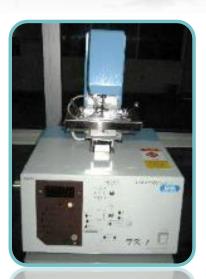
GEN3 Solderability Tester



MITUTOYO Hardness Tester



STRUERS Grinding and Polishing Machine



MALCOM Tackiness Tester





SHIMADZU Tensile Tester



LABOCut



RIGAKU Differential Scanning Calorimeter





DEK Printing Machine



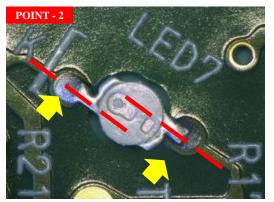
Vitronics Soltec Wave Soldering Machine



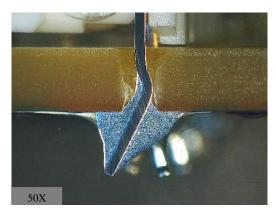
Failure Analysis

Cross Section Analysis - Observation

Digital Microscope

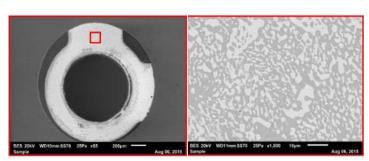


Surface observation

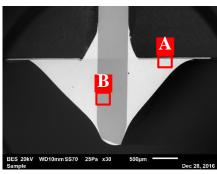


Cross section sample observation

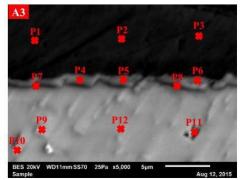
SEM/EDX



Surface observation



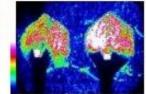
Cross section sample observation

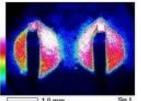


BES 20kV WD10mmSS70 25Pa x2,500 10µm Feb 26, 2016

Point / Area analysis





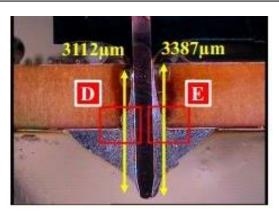


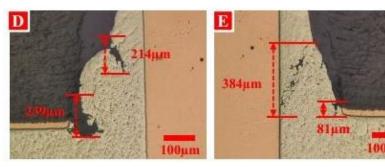
Color Mapping analysis

Failure Analysis

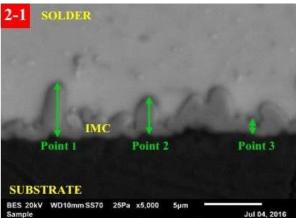
Cross Section Analysis - Measurement

Digital Microscope

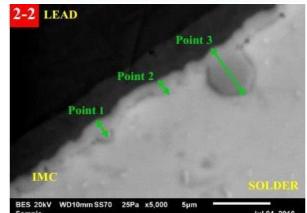




SEM

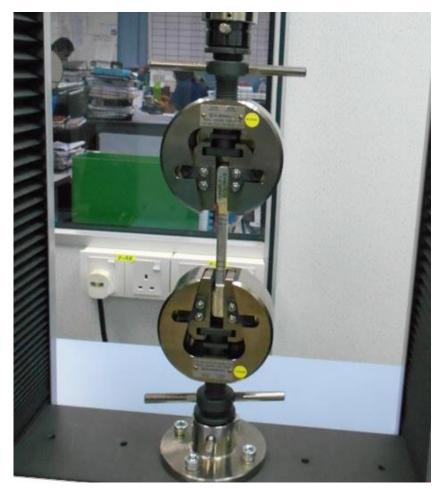


	THE RESERVE OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED		
Location of Measurement	Point 1	Point 2	Point 3
IMC Thickness (µm)	4.880	3.380	1.720
Average (µm)	3.327		

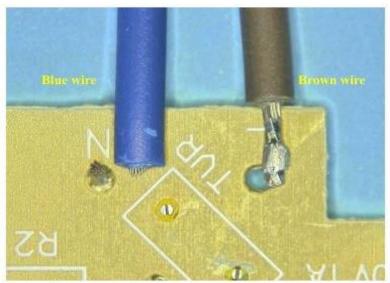


Sample	Jul 04, 2016			
Location of Measurement	Point 1	Point 2	Point 3	
IMC Thickness (µm)	2.369	1.476	4.985	
Average (µm)	2.943			

Failure Analysis Tensile Strength Test



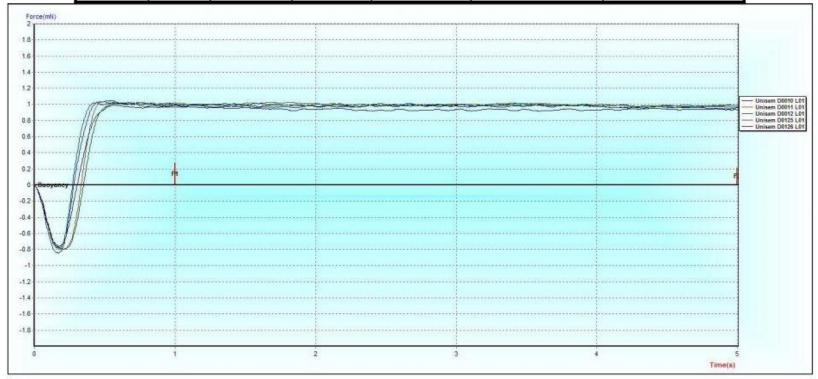
Elongation test



Pull test

Failure Analysis Wetting Balance Test

Test No.	Test Parameter					
	$T_0(s)$	F1 (mN)	F5 (mN)	Fmax (mN)	2/3 Fmax (mN)	Time to 2/3 Fmax (s)
1	0.282	1.005	0.960	1.048	0.699	0.357
2	0.333	1.019	0.989	1.037	0.691	0.393
3	0.351	0.994	0.969	1.021	0.681	0.420
4	0.273	0.987	0.988	1.030	0.687	0.333
5	0.306	0.970	0.933	0.996	0.664	0.390



Your Local Contact





●本社(大阪)

〒564-0063 大阪府吹田市江坂町1-16-15(NSビル) TEL: 06-6380-1121 (代表)

FAX:06-6380-1262

●東京営業所

〒135-0042 東京都江東区木場2-7-15 第一びる別館4F

TEL:03-3642-5234(代表) FAX:03-3642-5257

●名古屋営業所

〒466-0059 名古屋市昭和区福江2-5-4-802

TEL:052-882-6011 FAX:052-871-2434

〇津山工場

〒708-1215 岡山県津山市杉宮778-1

TEL: 0868-29-3240 FAX: 0868-29-2242

❷豊中工場

〒561-0894 大阪府豊中市勝部1-9-21

TEL:06-6843-7591 FAX:06-6853-7204 **〇大阪物流センター**

〒561-0894 大阪府豊中市勝部1-9-21

TEL:06-6843-7591 FAX:06-6853-7204 **OR&Dセンター**

〒561-0894 大阪府豊中市勝部1-9-15

TEL:06-6843-7155 FAX:06-6843-7733



●中国

NIHON SUPERIOR (SHANGHAI) CO., LTD.

29 Floor-H, Shang-Shi Building, No.18 Caoxibei Road, Xuhui District, Shanghai, 200030 China

TEL: +86-(0)21-6427-0038 FAX: +86-(0)21-6441-0554

NIHON SUPERIOR (SHANGHAI) CO., LTD. DONGGUAN BRANCH

8-B Xingye Building, 89 Lianfeng Road, Chang'an, Dongguan, Guangdong, 523850 China

TEL: +86-(0)769-82750225 FAX: +86-(0)769-82750226

NIHON SUPERIOR (SUZHOU) CO., LTD.

Loufeng Under Taking Development Square No.11 Yanghe Road,

Suzhou Industrial Park, 215122 China

TEL: +86-(0)512-6748-8352

FAX: +86-(0)512-6748-8551



●インドネシア

NIHON SUPERIOR (SINGAPORE) PTE. LTD.

INDONESIA REPRESENTATIVE OFFICE

Wisma 46-Kota BNI, #48-04 Jl. Jendral Sudirman Kav.1, Jakarta 10220 - Indonesia

TEL: +62-815-8416-3010



(::







●アメリカ

NIHON SUPERIOR USA, LLC

1395 Hawk Island Dr Osage Beach, MO, 65065, U.S.A.

TEL: +1-573-280-2357 FAX: +1-619-923-2714

●マレーシア

NIHON SUPERIOR (M) SDN. BHD.

Lot17, Jalan, Industri 1, Free Industrial Zone, Jelapang II, 30020 Ipoh,

Perak, Malaysia TEL: +60-(0)5-527-3792

FAX: +60-(0)5-527-3659

NIHON SUPERIOR ASIA SDN. BHD.

Unit No.5, Level 13A, Block 5, MenaraVSQ@ PJ City Centre, JalanUtara,

46200 PetalingJaya, Selangor, Malaysia

TEL: +60-(0)3-7932-5875 FAX: +60-(0)3-7931-5892

●シンガポール

NIHON SUPERIOR (SINGAPORE) PTE. LTD.

5 Harper Road #04-03, Singapore 369673

TEL: +65-6741-4633 FAX: +65-6741-6636

●台湾

NIHON SUPERIOR (TAIWAN) CO.,LTD.

4F., No.1, Sec.2, Dasing West Rd., Taoyuan City, Taoyuan 33046,

Taiwan R.O.C.

TEL: +886-(0)3-215-1119 FAX: +886-(0)3-215-1335

●タイ

NIHON SUPERIOR (THAILAND) CO., LTD.

13th Floor Unit G, 216/56 L.P.N. Tower, Nanglinchee Rd, Chong Non See, Yannawa,

See, Yannawa, Bangkok, 10120 Thailand

TEL: +66-(0)2-285-4471 FAX: +66-(0)2-285-4358

●ベトナム

REPRESENTATIVE OF NIHON SUPERIOR (THAILAND) CO., LTD. IN

HANOI
Hoa Binh International Towers. 11th Floor 106 Hoang Quoc Viet Street

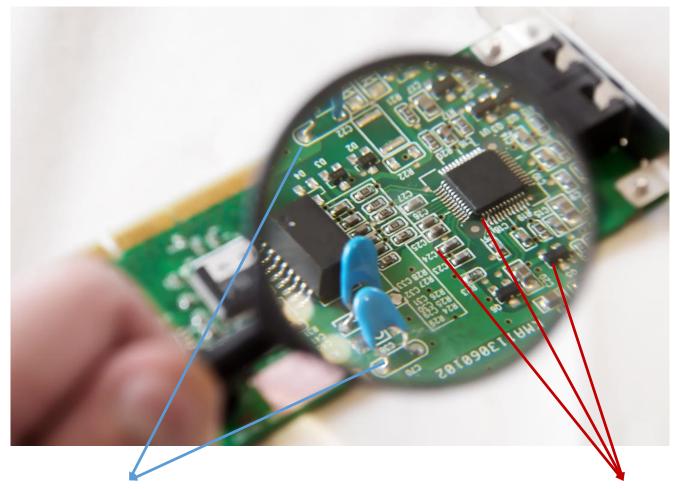
Nghia Do ward Cau Giay District, Hanoi City, Vietnam

TEL: +84-4-3-7689755 FAX: +84-4-3-7689757



Agenda

- Who are we?
- Who are our technical partners?
- What can we offer besides material?
- SMT knowhow



Through-hole component

- Wave soldering
- Selective soldering
- Manual soldering

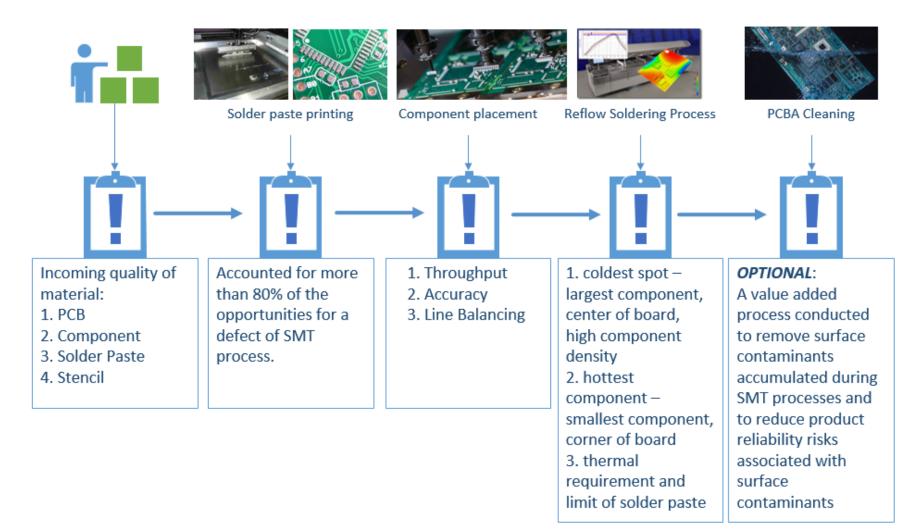
Surface mount technology, SMT component

- SMT Reflow Soldering
- Wave soldering, (certain limitations.
 not applicable to fine pitch component)

https://learn.sparkfun.com/tutorials/integrated-circuits/ic-packages

SMT Process

All the processes that control the formation of solder joints such as solder paste printing, reflow soldering, wave soldering, selective soldering, hand solder etc. control a significant majority of the opportunities for a defect

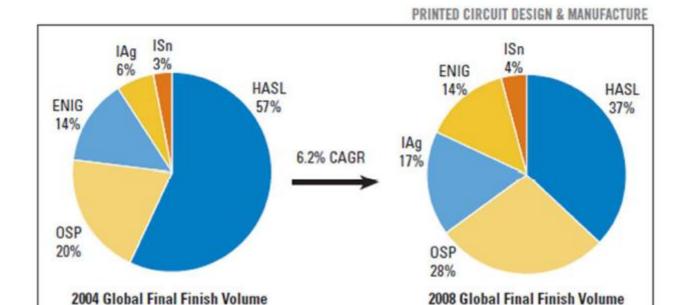


Surface Finishes to Protect Cu Pad

 Cu is highly vulnerable to oxidation. Need surface protection to preserve the solderable surfaces as the PCB moves from PCB house to assembly

- Most common surface finishes:
 - Cu OSP (organic solderability preservative)
 - ENIG (electroless nickel immersion gold)
 - HASL (hot air solder leveling, SnPb or SN100C)
 - ImAg (immersion silver)
 - ImSn (immersion tin)

Surface Finishes to Protect Cu Pad



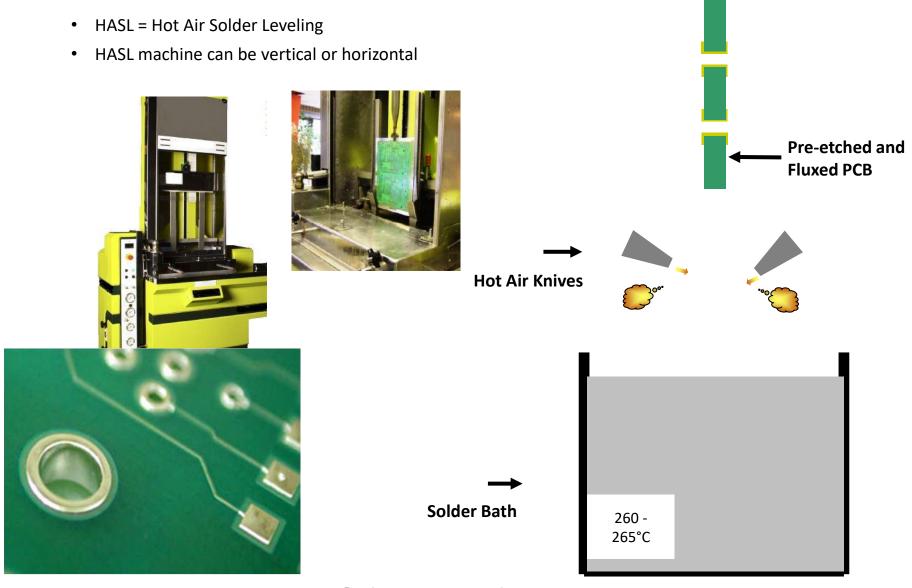
Worldwide final finish market for 2004 and projection for 2008.

1993 million bd sq. ft.

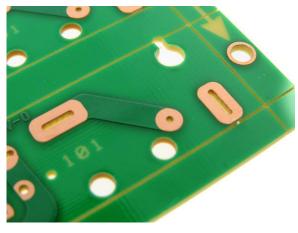
Source: Printed Circuit Design & Manufacture, March 2007

1568.2 million bd sq. ft.

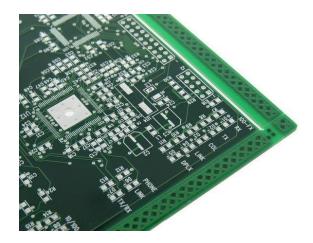
What is HASL



Cu OSP, ENIG, Im Ag, Im Sn



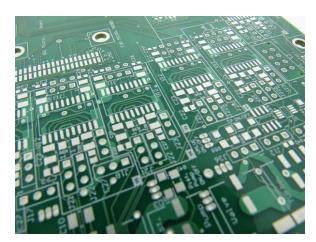
Cu OSP



Im Ag

TP2 Q D7 S RVI

ENIG



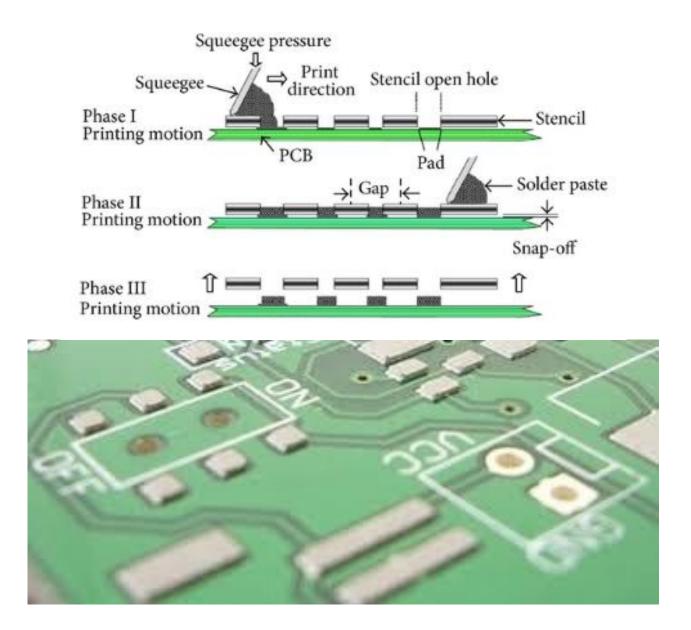
Im Sn

Solder Paste Deposition

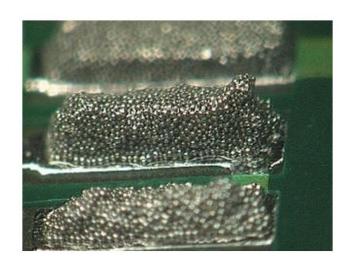


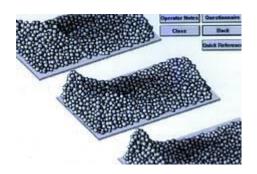
Printing Process is Critical

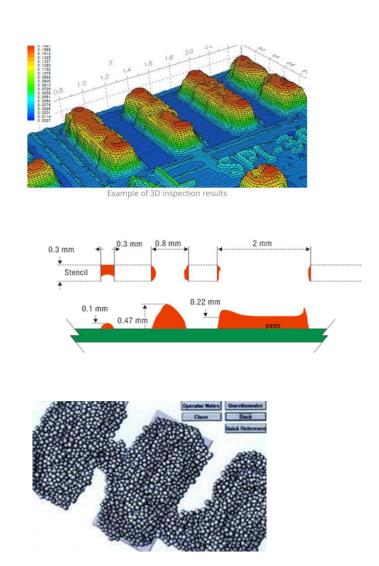
- The formation of solder joints:
 - Solder paste printing
 - Component placement
 - Solder reflow process
- A case study revealed that the solder paste printing process controlled in excess 80% of the opportunities for a defect
- There are many factor that influence the performance of the solder paste printing process



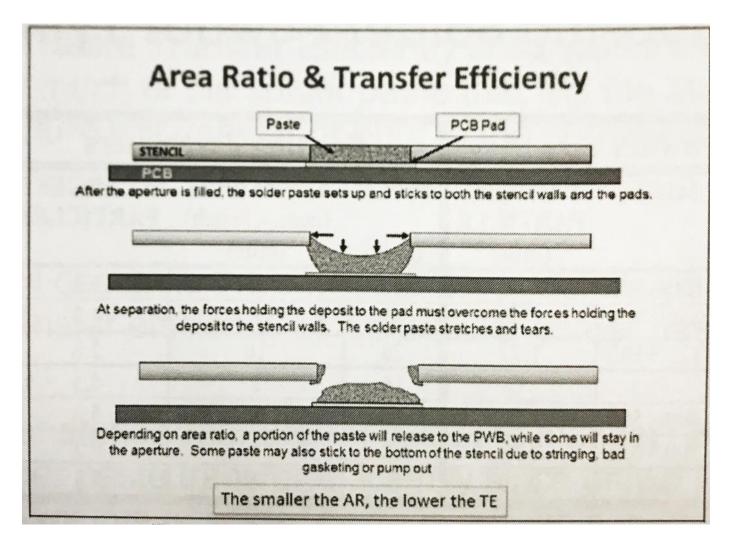
This is what we/your manager expects to see, IDEAL case







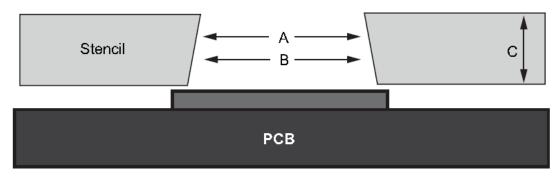
But this is what likely to be...



During the printing process, when the stencil separates from the substrate, competing surface tension forces dictate whether the solder paste will transfer to the pad it has been printed on or remain adhered to the stencil aperture walls

Stencil Design

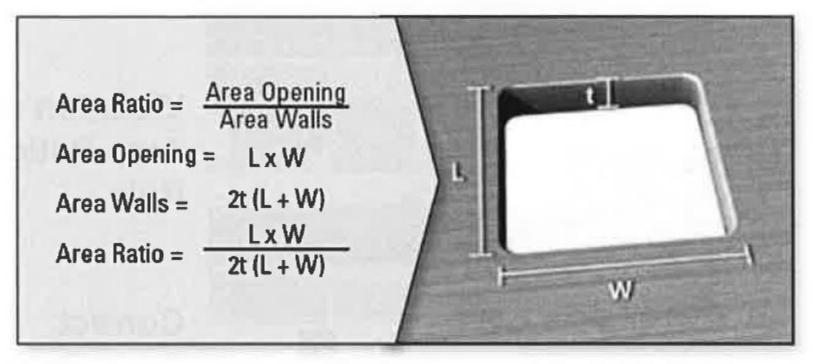
- IPC-7525B—Stencil Design Guidelines
- Stencil thickness ranging from 100-150 μm
- Aspect Ratio = Width of Aperture Opening/Stencil Foil Thickness = W/T, must be greater than 1.5
- Area Ratio = Area of Aperture Opening/Area of Aperture Walls = W × L
 / 2 × (L+W) × T, must be greater than 0.66
- Aspect ratio relates to stencil manufacturing and area ratio relates to paste release



Stencil apertures should be tapered to produce more uniform release of solder paste.

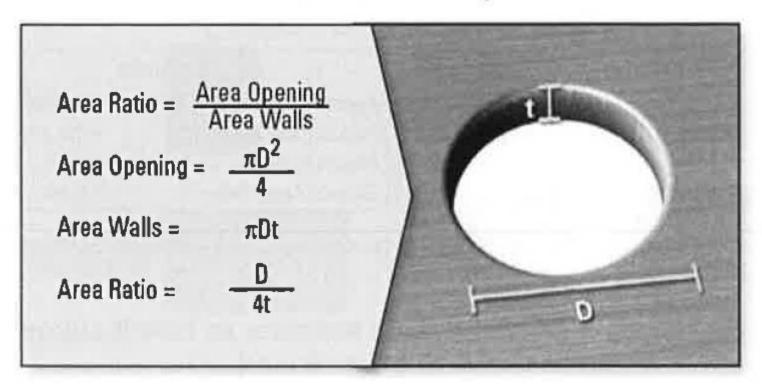
Area Ratio for Square and Rectangular Apertures

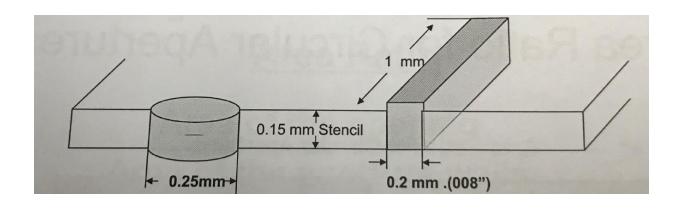
Area Ratio For Square/Rectangular Apertures



Area Ratio for Circular Apertures

Area Ratio For Circular Apertures





Circle	Rectangle
Aperture wall area = $2\pi r$ = 0.118 mm ²	Aperture wall area = 2WT+2LT = 0.36 mm ²
Pad surface area = πr^2 = 0.049 mm ²	Pad surface area = WL = 0.2 mm ²
Aspect Ratio = 1.67	Aspect Ratio = 1.34
Area Ratio = 0.42	Area Ratio = 0.56

In most of the cases, rectangular aperture has better release

Area Ratio (AR) and Transfer Efficiency (TE)

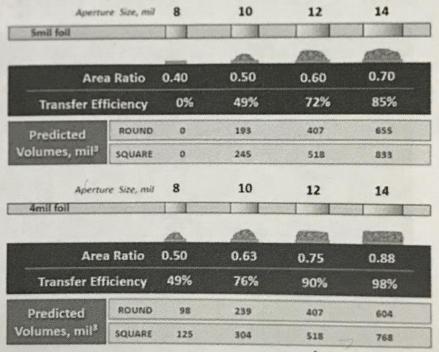


image courtesy of ALPHA stencils

4mil foil gives larger deposit



Smil foil gives larger deposit

Nano Coating Helps Paste Transfer and Print Definition

	Minimum Area Ratio (AR)	
Material	No Stencil Coating	NanoSlic Gold™
Slic™ Metal	0.55	0.45
(2-5 micron grain size)	0.55	
UltraSlic™ Metal	0.50	0.40
(1-2 micron grain size)		0.40

^{*}Lower area ratios can be achieved depending upon the application.

NANOSLIC STENCILS

The NanoSlic® stencil is the most advanced solder paste stencil available today. The coating was developed by Florida CirTech chemists to achieve a durable, paste repelling coating that improves stencil printing significantly. Building on the proven benefits of the Slic™ stencil, advanced chemistry is used to impart a highly Hydrophobic & Oleophobic surface to the apertures and underside of the stencil. This non-stick surface resists solder paste buildup, significantly reducing the need for cleaning cycles. The Nano coating is permanently bonded to and conforms to aperture walls regardless of size or geometry. The NanoSlic® stencil improves paste release, enabling high yield printing at low area SARs (surface area ratios). NanoSlic® has a robust surface that stands up to repeated cleaning.





Laser cut no surface treatment side wall



Laser cut with electro-polish wall

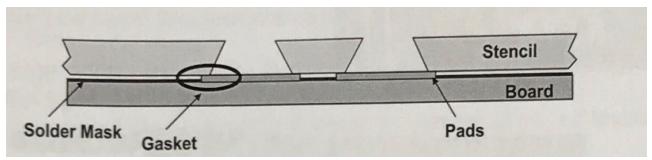
To smooth the aperture wall:

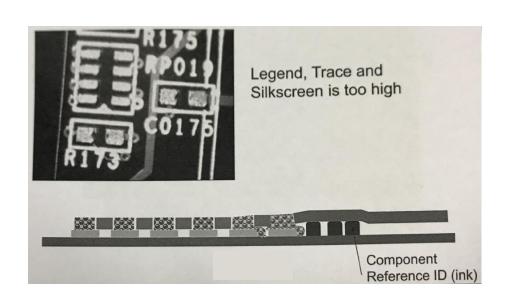
- 1. Electropolishing
- 2. Microetching
- 3. Nickel plating

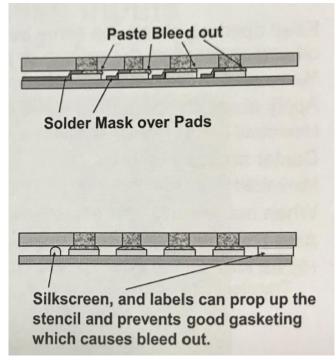
**An aperture oriented with its long axis in the same direction as the blade stroke does not fill as well as an aperture oriented with its short axis to the blade stroke.

Stencil Gasketing (Sealing)

Besides high squeegee pressure (recommended pressure is 0.5kg of pressure per 25mm squeegee blade), broken seal between stencil aperture and PCB component pad will cause paste bleeding or solder shorts





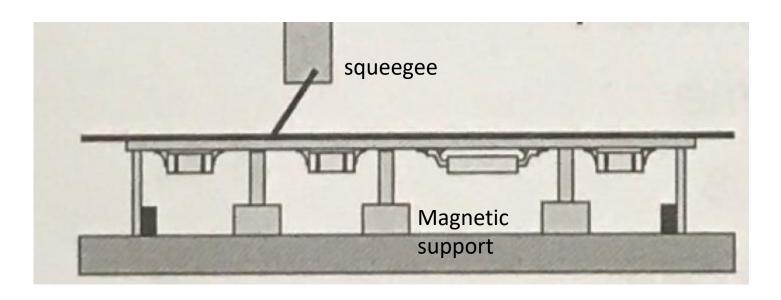


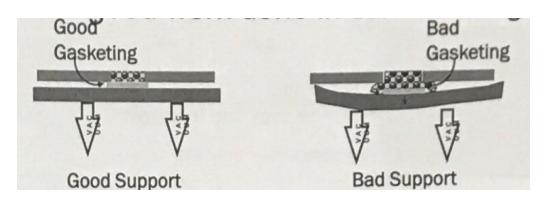
Board Support



Example of adaptable PCB support in use

Besides what mentioned earlier, PCB support is important to have good solder paste printing and paste release. There are high pressure from printing stroke





- Ensure the manually inserted support pins do not contact bottom side components. If a support pin contacts a bottom side component printing defects will occur and likely damage to the bottom side component
- Poor board support can erase all the good work done in stencil design

Board Stencil Separation Speed

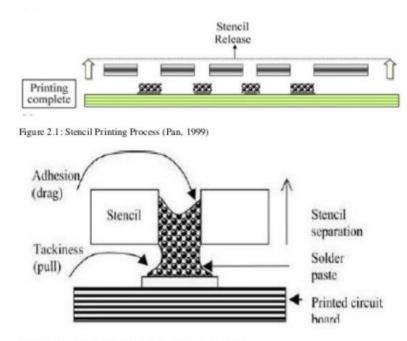
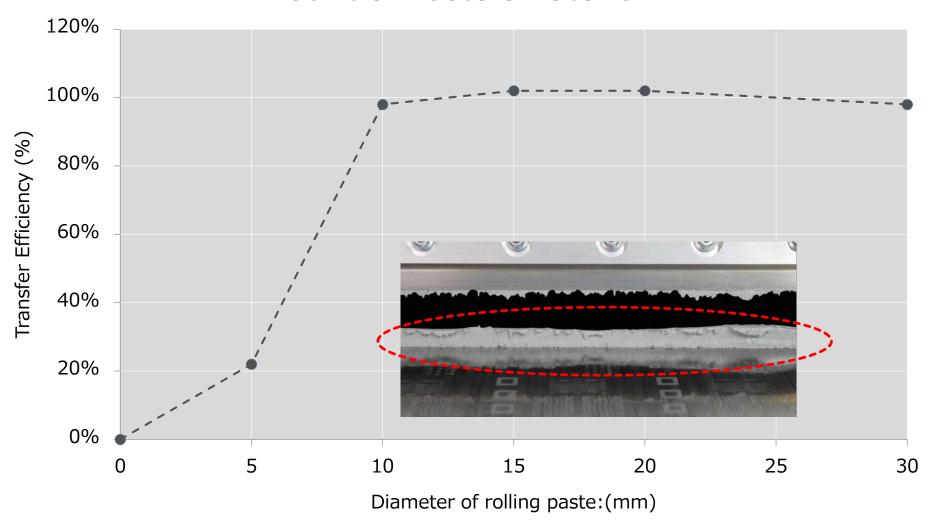


Figure 2.2: Aperture Emptying Process (Durairaj, 2001)

- The separation of board from stencil needs to be controlled
- Time should be sufficient to allow paste deposit clears the aperture then faster separation speed, slow snap off
- This is why good printer should have allowed 2 speed controls for this process

Amount of Paste on Stencil



- When the diameter of rolling paste smaller than 10mm, the transfer efficiency drops significantly.
- Recommended diameter is 10-15mm
- It is important to replenish the paste regularly

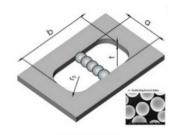
General Guideline in Printing Parameters

Item	推奨値/Recommend	Tolerance or other options
Type of Stencil	Laser (Stainless)	Additive , Etching, Electroform, coated with nano material
Squeeze material	Metal	Urethane
Squeeze angle	∠60°	∠45°-∠60°
Printing speed	50mm/sec	20-100mm/sec
Printing pressure	20g/mm (For example, a 300mm blade needs 6.0kg)	10-30g/mm
Separation speed	1.0mm/sec	0.5-2.0mm/sec
Ambient environment	Temperature: 25℃ Humidity:40%RH	Temperature: ±3℃ Humidity: ±20%RH
Delta temperature of paste on stencil	±1℃	±2℃
Diameter of rolling paste	Φ15mm	φ10-20mm
Aspect ratio of stencil aperture	0.6以上	0.5以上

Printing speed has been tested in range of 2-150mm/s. The increase of printing speed will reduce the printability of paste. It is necessary to increase the printing pressure for high speed of printing. However, high pressure will increase the stress on stencil and squeegee. A balance needs to be maintained in printing speed and pressure

Solder Paste

Particle size in microns	Particle type
75-45	2
45-25	3
38-20	4
25-15	5
15-5	6





Form a permanent metallurgical bond between 2 or more metallic surfaces





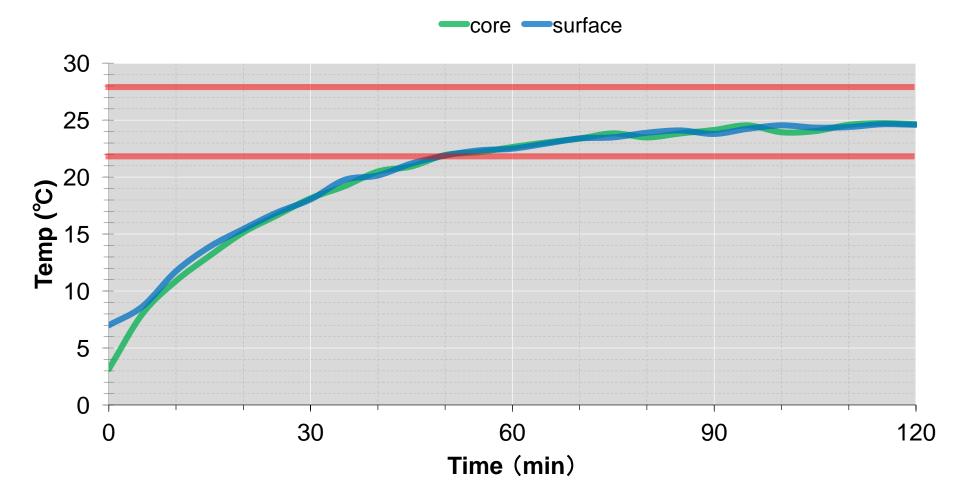
- 1. Suspends the powder to maintain the homogeneous mixture
- 2. Chemically removes oxide from the components, the PCB pads and surface of solder powder

For printing application, 90% metal content by weight but 50/50% is metal/flux by volume! Now, you can understand the difference of powder and flux density

- Please keep this paste in refrigerator(at 0-10degC).
- Please do not open the container before the contents reach room temperature to avoid condensation of moisture on the paste.
- Please use by room temperature.
- Please do not mix solder paste from the stencil with unused paste in the jar
- Please mix at 1-2minutes to take care so as to prevent bubbles.
 - *Solder paste mixer condition:1minute at 1000rpm.



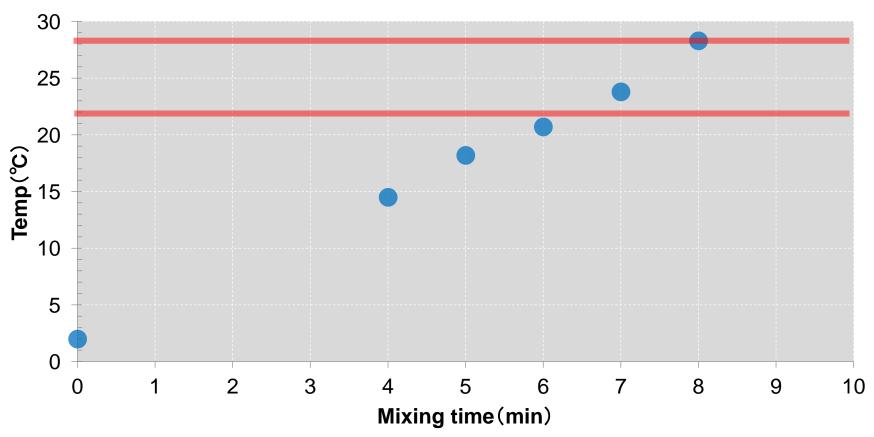
Thawing time for solder paste



At room temperature of 25° C, the solder paste will reach room temperature at approximately one hour

Centrifugal spinning can warm the paste faster:

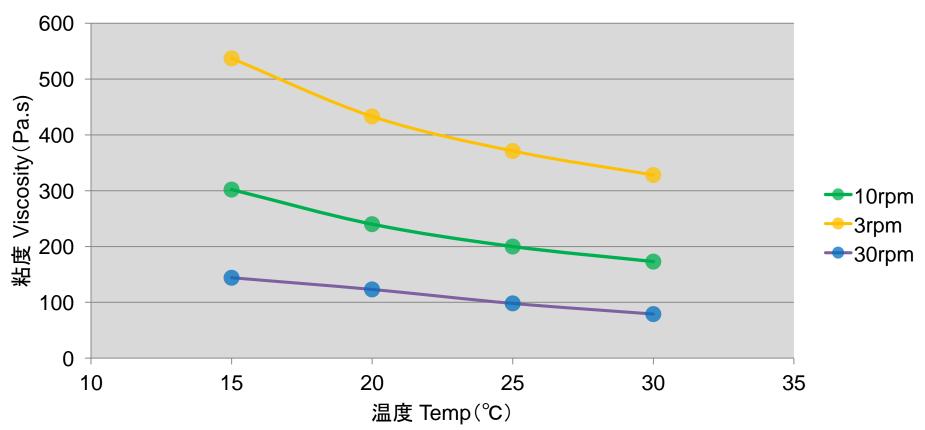




Paste temperature will reach room temperature with 1000rpm spinning for 7-8 minutes.

But don't warm or spin the paste too much!



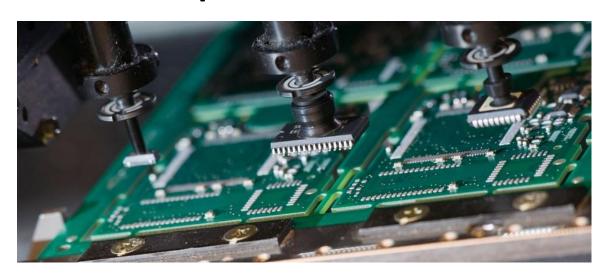


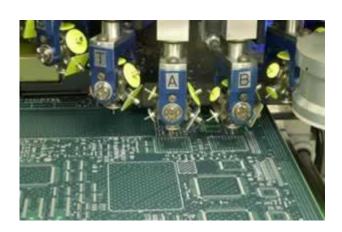
Solder Paste Inspection, SPI



Some common brands such as CyberOptics, Koh Young

Component Placement

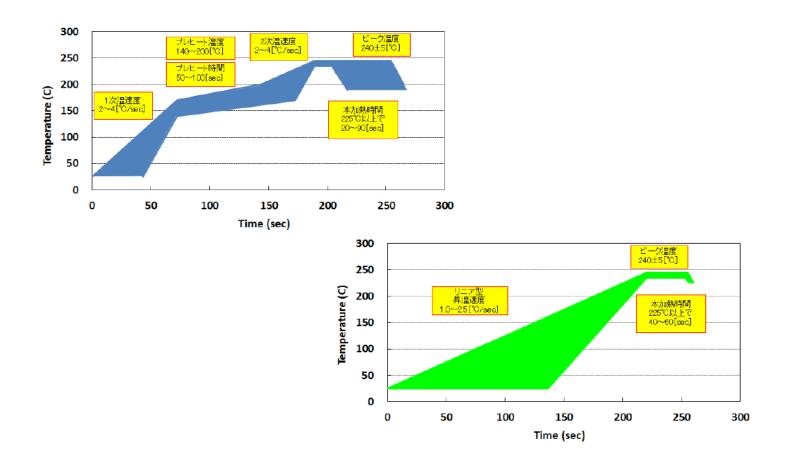






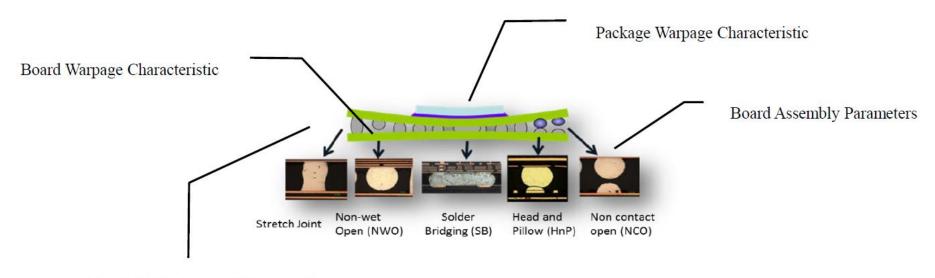
Some familiar names such as ASM, Assembleon, Europlacer, Fuji, Hitachi, Juki, Mirae, Mydata, Panasonic, Samsung, Universal, Yamaha and others

Reflow Soldering Process

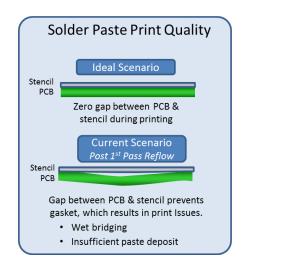


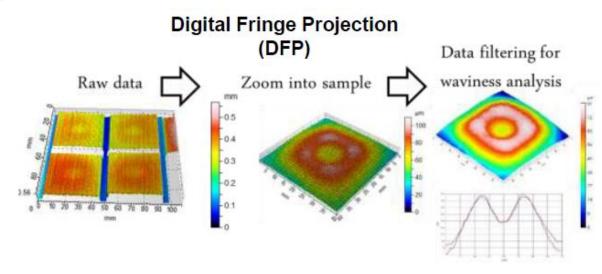
This is only recommendation of solder paste supplier. This is not a specification. But the limit of preheat or soaking (temperature, duration and ramp rate) needs to be followed strictly to keep the activity of flux till end of reflow process

Warpage of PCB and SMT component



Material selections: solder paste, flux





Uncontrolled PCB and component warpage leads to Print and SMT defects and eventually a reliability concern!



Conclusion

- No single factor which is responsible for a defect
- Any step/process during the SMT can be part of the root cause
- Need to have full understanding the steps in SMT in order to have continuous improvement
- Due to rigidity of SMT component and small solder volume, solder joint reliability is a crucial topic for this process