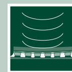
Semiconductor Assembly

Materials Science

Solder Fluxes
- Flip-Chip Flux
- Ball Attach Flux
- Wafer Flux
- PoP Flux

Solder Pastes
- Die-Attach Paste
- LED Mounting Paste
- Au/Sn Paste
- Indium Alloy Paste
- Substrate Paste

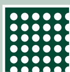


Polymers/ Underfills
- Epoxy Fluxes
- No-Flow Underfills
- Conductive Adhesives

Metal TIMs
- Compressible
- Heat-Spring™
- Liquid Metals

Solder Wire
- Fluxless Die-Attach (SSDA) Grade
- Pb-Free Wire
- High-Pb Wire

Solder Preforms
- LED
- Lids
- Seals
- Package-on-Package (PoP)

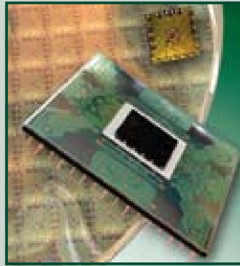


Solder Spheres
- 0.1 to 0.76mm
- Pb-Free Spheres
- High-Pb Spheres

Other Brochures Available:
- **PCB Assembly Materials**
- **Thermal Interface Materials**
- **Engineered Solders**

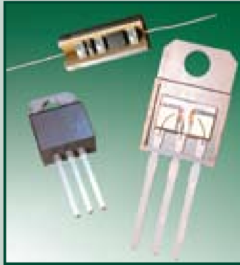
Applications

Semiconductor Packaging



- Bump fusion wafer fluxes
- Flip-Chip fluxes
- Package-on-Package
- Ball Attach

Power Semiconductors



- Lead frame and hybrid assembly
- Die-Attach solder paste
- Die-Attach solder wire
- Die-Attach solder preforms

Thermal Management

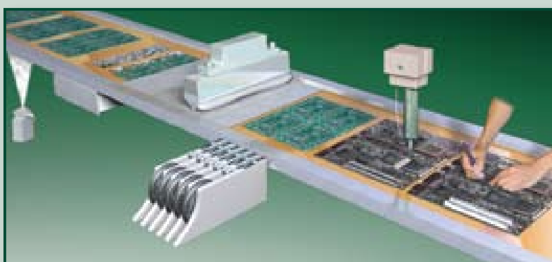
- Metal TIMs
  - *Shims/Preforms*
  - *Compressible alloys*
  - *Liquid metals*
- 86 W/mK conductivity
- Accommodates CTE mismatch

Engineered Solders

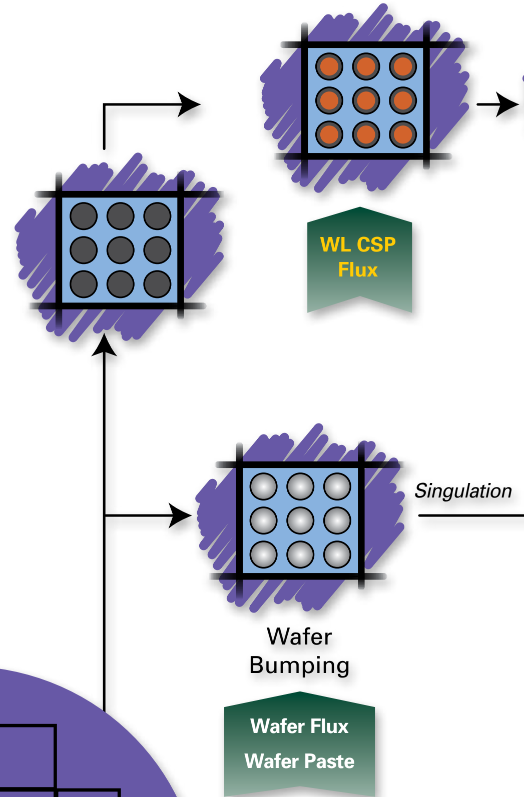
- Fluxless Die-Attach
- Hermetic sealing
- Pin soldering
- Other speciality

PCB Assembly

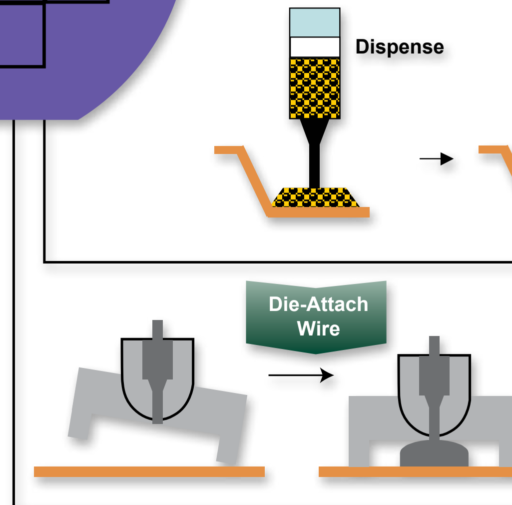
- Stencil print
- Wave solder
- Pin-in-Paste+
- Underfill
- Solder TIMs
- Rework & repair
- Package-on-Package
- System-in-Package



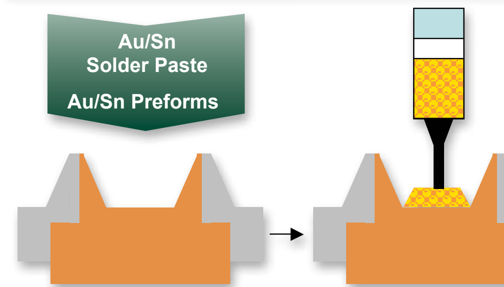
Semiconductor Packaging

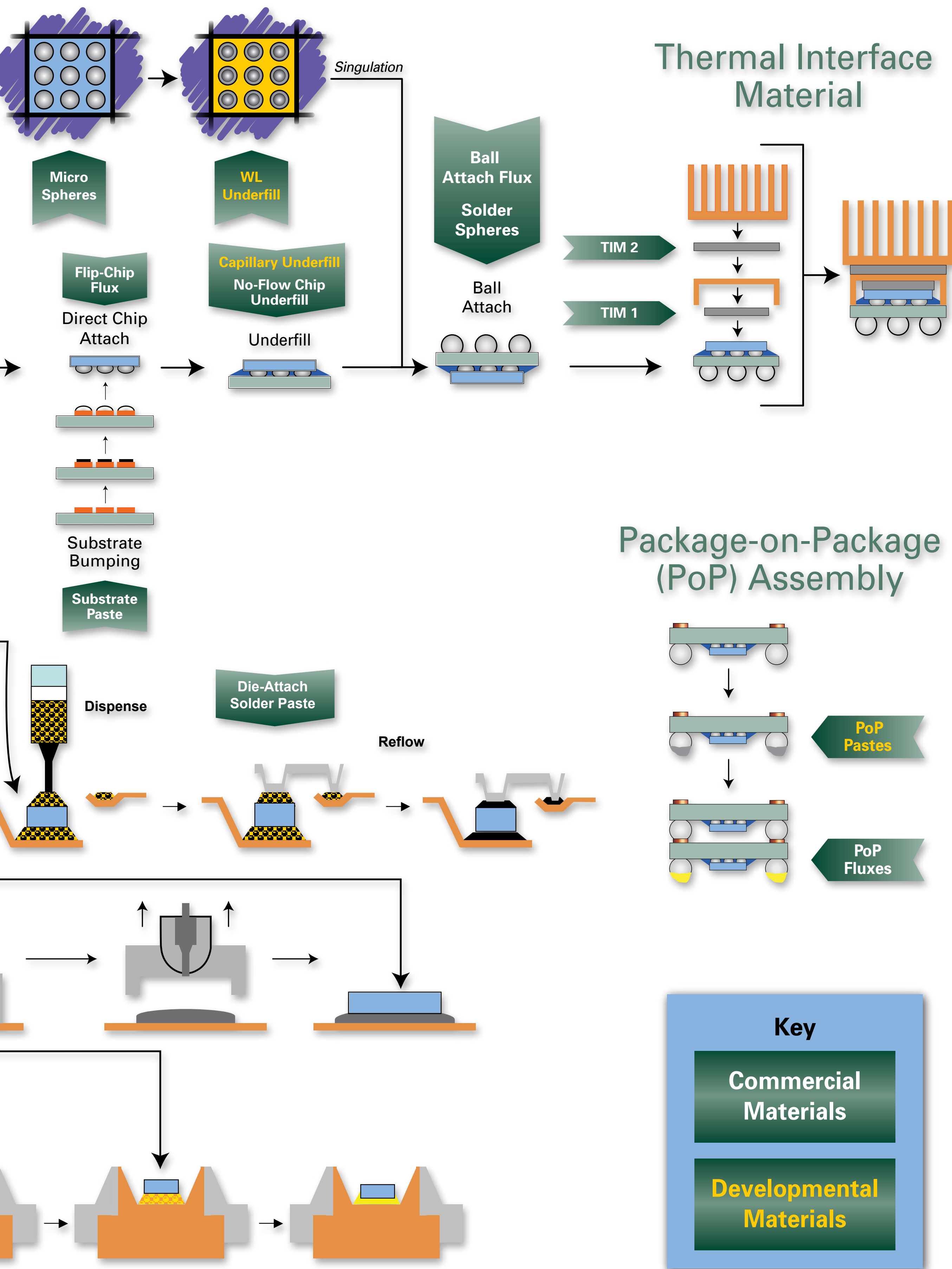


Die-Attach



LED Manufacture





Thermal Interface Material

Package-on-Package (PoP) Assembly

Key

Commercial Materials

Developmental Materials

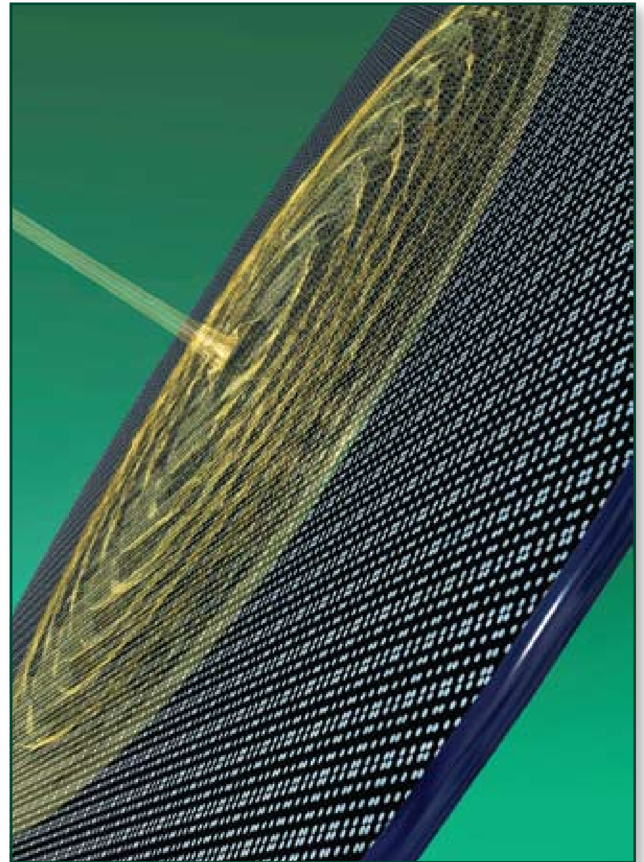
To request a full-size copy of this poster, please email askus@indium.com

INDIUM CORPORATION®

Wafer Fluxes

Introduction

Indium Corporation's **Wafer Fluxes** are low-viscosity (typically less than 120cSt) rheologically-optimized Semiconductor-Grade liquid fluxes. **Wafer Fluxes** are applied to the surface of wafers after either a solder-deposition process (usually plating), or bump deformation after known good die (KGD) probe testing.



Key Performance Needs:

- Bump co-planarity and singularity
- Consistent bump shape across the wafer surface
- No "wraparound" (wafer backside contamination)
- No delamination during subsequent underfill operation (good cleanability)
- No UBM corrosion

Application Note: Cleaning

Solvent-clean materials may be cleaned with either mesitylene, terpene-based material, or a semi-aqueous solution.

Water-soluble materials are optimized to be cleaned with deionized water at room temperature.

Wafer Flux Product Selector

					Compatible Alloys					
Product Name	Cleaning Method	Application Method	Flux Designation (1)	Halide-Free	SAC Alloys	High Pb & Au/Sn	63Sn	Reflow Atmosphere	Wafer Diameter	Used in HVM (2)
SC-5R	Solvent-clean	Spraying / spincoating	ROL0	Yes	Yes	Yes	Yes	Nitrogen (<20ppm O_2) or $4\%H_2/N_2$	100-300mm	Yes
WS-3401	Water-soluble	Spraying / spincoating	ORM0	Yes	Yes	No	Yes	Nitrogen (<20ppm O_2) or $4\%H_2/N_2$	100-200mm	Yes
WS-3543	Water-soluble	Spraying / spincoating	ORM0	Yes	Yes	No	Yes	Nitrogen (<20ppm O_2) or $4\%H_2/N_2$	100-300mm	Yes

(1) Per ANSI/IPC TM650: J-STD-004

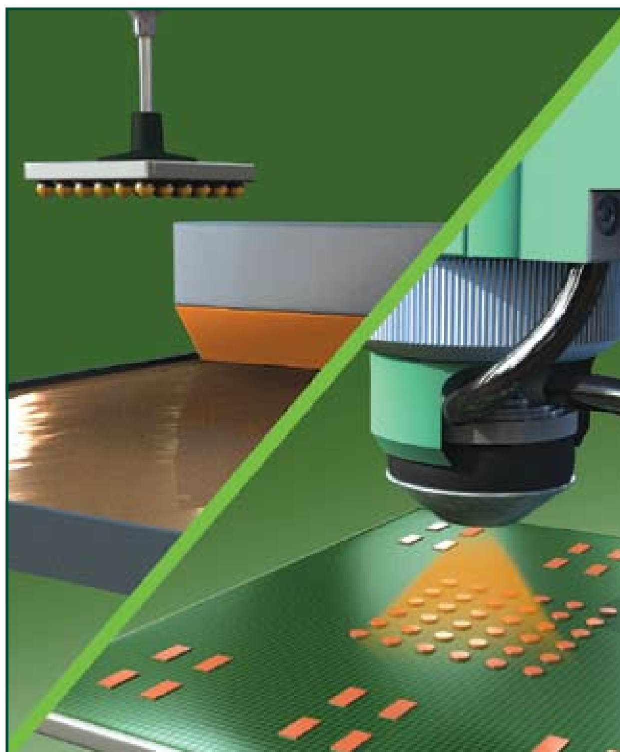
(2) High Volume Manufacturing

Flip-Chip Fluxes

Introduction

Indium Corporation's **Flip-Chip Fluxes** are moderate viscosity fluxes (typically 50cSt to 100kcps) used to solder a bumped or copper-column flip-chip to a substrate in the direct chip attach (DCA) process. The substrate pads may be metallized/OSP-bearing, pre-bumped with solder, or printed with substrate paste.

Flip-Chip Fluxes are typically applied by either spraying, dipping, or a combination of spraying and dipping.



Key Performance Needs:

- Controlled and time-stable rheology
- Particle-free spray
- Homogeneous dip
- No part movement during reflow
- Consistent solderability
- Reflow at 5 — 25ppm O_2 in nitrogen
- Process compatibility:
  - High and low reflow temperatures
  - Cleanable (water-soluble) or Epoxy-compatible (NC/EP)

Application Note: Underfill Compatibility

As the number of I/Os in CPUs and GPUs moves above 5,000, the most common technology for water-soluble fluxes is either a higher-solids spray flux (such as WS-3500), or a combination (such as WS-3500 and the WS-367). Above 10,000 I/Os, clearances are typically too low to allow cleaning, so low-solids no-clean fluxes are preferred.

The compatibility of fluxes with subsequent underfill processing is dependent either on the cleanliness of the area under the chip (water-soluble fluxes) or the compatibility of the residue with the underfill material (no-clean fluxes). Testing has shown that underfill compatibility with no-clean fluxes is a combined function of the reflow process, underfill curing process, and underfill chemistry.

Flip-Chip Flux Product Selector

					Compatible Alloys				
Product Name	Cleaning Method	Application Method	Flux Designation (1)	Halide-Free	SAC Alloys	High Pb & Au/Sn	63Sn	Residue %	Used in HVM (2)
WS-3500	Water-soluble	Spray	ORM0	Yes	Yes	Yes	Yes	n/a	Yes
WS-367	Water-soluble	Dipping	ORH1	No	Yes	Yes	Yes	n/a	Yes
FC-NC-HT-A1	No-clean	Spray	ORL0	Yes	Yes	Yes	Yes	< 1%	Yes
NC-510	No-clean	Dipping	ORL0	Yes	Yes	No	Yes	4%	Yes

(1) Per ANSI/IPC TM650: J-STD-004

(2) High Volume Manufacturing

INDIUM CORPORATION®

Ball Attach Fluxes

Introduction

Indium Corporation's **Ball Attach Fluxes** are viscous fluxes (typically 100kcps to 1000kcps) used to attach solder spheres to the bottom of ball-grid array (BGA) packages. We offer a variety of materials, suited to specific process needs, from halide-free water-soluble fluxes to no-clean materials suitable for wetting nickel.

Key Performance Needs:

- Particle-, crystal-, bubble-free
- Homogeneous
- Controlled and time-stable rheology
- Consistent solderability
- No part movement during reflow
- Reflow in air
- Wetting onto a variety of metals: copper, ENIG, bare nickel
- Cleanable, even after high temperature air reflow

Application Note: Pin Transfer

Ball Attach Fluxes are typically applied to packages using the pin-transfer process. An array of spring-loaded pins is immersed in a doctor-bladed flux reservoir of a particular depth. The pins are then pushed onto the bottom of the BGA package to transfer the flux. Solder spheres are then placed in the flux deposits and the package is reflowed.

Ball-Attach Flux Product Selector

						Compatible Alloys			
Product Name	Cleaning Method	Application Method	Flux Designation (1)	Halide-Free	Sphere Size	SAC Alloys	High Pb & Au/Sn	63Sn	Residue % (2)
WS-3600	Water-soluble	Pin-transfer / Printing	ORH1	No	>0.30mm	Yes	No	Yes	None
WS-3622	Water-soluble	Pin transfer / Printing	ORH1	No	≤0.30mm	Yes	No	Yes	None
WS-366	Water-soluble	Printing / Pin-transfer	ORH1	No	Any	Yes	Yes	Yes	None
WS-364	Water-soluble	Printing / Pin-transfer	ORM0	Yes	Any	Yes	Yes	Yes	None
NC 506	No-clean	Pin-transfer / Printing	ROL1	No	Any	Yes	Yes	Yes	26%
NC-414	No-clean	Printing / Pin-transfer	ROL1	No	Any	Yes	No	Yes	48%
NC-026	No-clean	Pin-transfer	ROL0	Yes	Any	Yes	No	Yes	5%
NC-007	No-clean	Printing / Pin-transfer	ROL1	No	Any	Yes	Yes	Yes	47%

(1) Per ANSI/IPC TM650: J-STD-004

(2) Approximate residue level

Water-soluble Solderability Table

	Solder Alloy		
Metallization	**52In/48Sn**	**Sn/Pb**	**SAC 387**
ENIG	WS-366	WS-3600 WS-3611	WS-366
Immersion Silver	WS-364 WS-366	WS-3600 WS-3611	WS-363
Copper	WS-366	WS-364	WS-366
Oxidized Copper	WS-366 WS-3600 WS-3611	WS-366	WS-366
Nickel	WS-3600 WS-3611 WS-364	WS-3600 WS-3611	WS-3600 WS-3611
OSP	WS-364 WS-366	WS-3600 WS-3611	WS-366
Alloy 42	WS-3600 WS-3611 WS-364	WS-3600 WS-3611	WS-366

No-clean Solderability Table

	Solder Alloy		
Metallization	**52In/48Sn**	**Sn/Pb**	**SAC 387**
ENIG	NC-414	NC-414	NC-414
Immersion Silver	NC-414	NC 506	NC 506
Copper	NC-414	NC 506	NC 506
Oxidized Copper	NC 506	NC 506	NC 506
Nickel	NC 506	NC 506	NC 506
OSP	NC 506 NC-414	NC 506 NC-414	NC 506
Alloy 42	NC 506	NC 506	NC 506

Reflow Atmosphere	Comments: (3)	Used in HVM (4)
Air	Red color for pre-reflow inspection; automated level detection (3)	Yes
Air	Red color. Designed for smaller spheres. High Tack	Yes
Air	Clear before reflow	Yes
Air	Halide-free	Yes
Air	Industry-leading material. Wets to oxidized nickel	Yes
Air	Wets to nickel	Yes
Nitrogen (<100ppm O2)	Halide-free. Ultralow residue. Underfill compatible	Not Yet
Air	Good for high temperature alloys	Yes

(3) For example: Zen Voce model ZVM380

(4) High Volume Manufacturing

Value-Added: No-Clean Ball Attach Properties

Indium Corporation fluxes offer two cost-saving process opportunities:

1. Although water soluble fluxes are currently favored by the Semiconductor Packaging industry, significant capital equipment and process cost savings can be obtained from the use of Indium Corporation no-clean materials.
2. By using clean bare nickel instead of Au/Ni, the expense of gold-plating can be avoided.

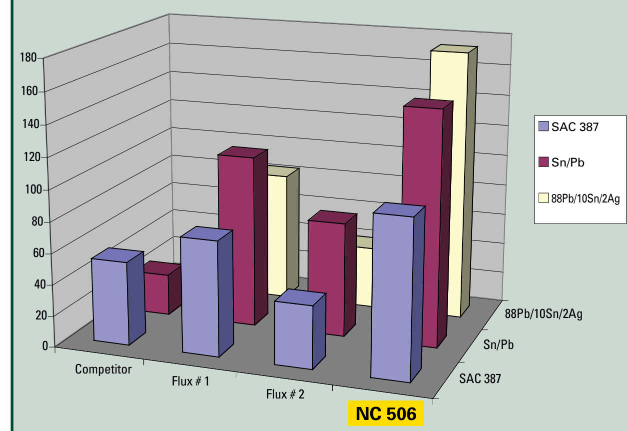
Award-Winning: Excellence in Semiconductor Packaging: NC-500 Series

Our **NC-500** Series Ball Attach Fluxes outperform all others in five key areas:

- Innovation
- Quality
- Speed/throughput improvements
- Cost-effectiveness
- Environmental responsibility

See why one major NC 506 user said, *"We cannot replace this flux from Indium Corporation."*

NC 506 and Alternative Fluxes: Wetting onto Nickel



Die-Attach Solder Pastes

Introduction

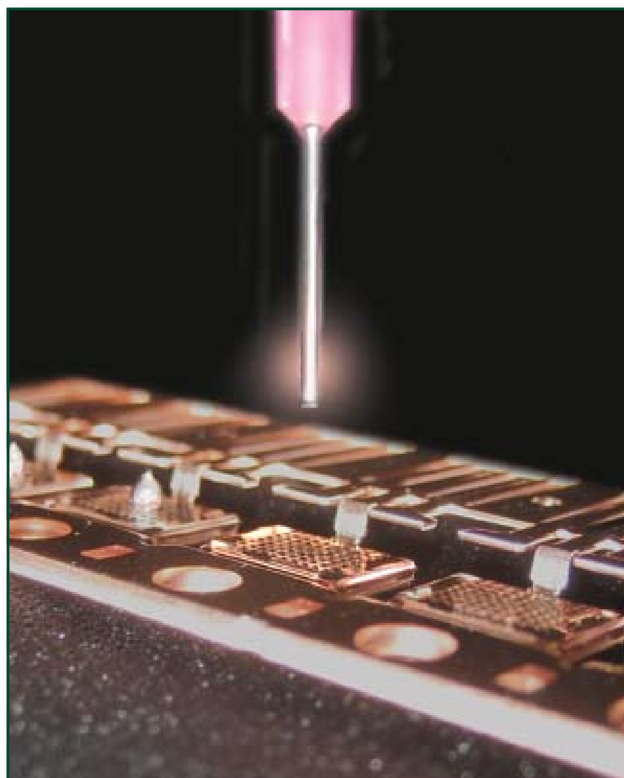
Although there are four major processes for die-attach (see table for comparisons), solder-based processes are still the most popular, as they provide high reliability with ease of processing. Indium Corporation's **Die-Attach Solder Paste** is typically a dispensable, high melting-point solder paste, which is reflowed in forming gas (H_2/N_2 mix).

Key Performance Needs:

- Low voiding in reflow
- Long dispense life
- No tailing
- No separation
- Bubble-free packaging
- Residue-free cleaning or residue compatible with overmolding process

Applicable Alloys:

Alloys used in die attach processes vary, depending on the manufacturing process requirements and end-use needs. A partial list of alloys often used in the die-attach process is given in the Die-Attach Solder Paste Alloys Table.



Processes for Die-Attach

Variables	Metal-Filled Polymers	Solder	Eutectic Bond	Metal / Frit
Material stability	Problematical	Some Issues	Good	Good
Automated application	Good	Good	Some Issues	Some Issues
Curing / Processing	Good	Good	Some Issues	Some Issues
Compatibility	Good	Good	Good	Some Issues
Voiding	Problematical	Some Issues	Good	Some Issues
Service life	Some Issues	Good	Some Issues	Some Issues
Thermal / Electrical conductivity	Some Issues	Good	Good	Problematical
CTE mismatch	Good	Good	Problematical	Problematical

Key: Good | Some Issues | Problematical

Die-Attach Solder Paste Product Selector

Product Name	Metal Load	Flux Designation (1)	Residue Level	Cleaning	Reflow Atmosphere	Application	Used in HVM (3)
Indium9.72	88.5%	ROL1	< 5%	Aqueous cleaning solutions known	Forming Gas (2)	Ultralow voiding, even on the largest packages. Long dispense life. Long cleaning bath life	Yes
Indium9.52	87.0%	REL0	2%	Designed to be no-clean. Cleaning solutions known	Forming Gas (2)	Low voiding. Light colored and extremely hard residue. Does not wet edges of unpassivated die	Yes
Indium9.32	89.0%	ORL0	0.4%	Aqueous cleaning solutions known	Forming Gas (2)	Ultralow residue. Minimal voiding when used with small die	Yes

(1) Per ANSI/IPC TM650: J-STD-004   *(2) 96%N_2, 4%H_2*   *(3) High Volume Manufacturing*

- *All dispense-only products*
- *All Indalloy 151: 92.5Pb/5.0Sn/2.5Ag*
- *Type 3 powder (-325/+500mesh)*
- *Minimum dispense needle is 20 gauge*

Indium9.72 Solder Paste

Although each Indium Corporation die-attach paste has a unique niche, **Indium9.72** is by far the most versatile material. The dispense life of this is very long (see Fig. 1). By adjusting the reflow profile to minimize voiding, yet avoiding the formation of intermetallics (see Fig. 2), a high reliability joint can be consistently produced.

Figure 1

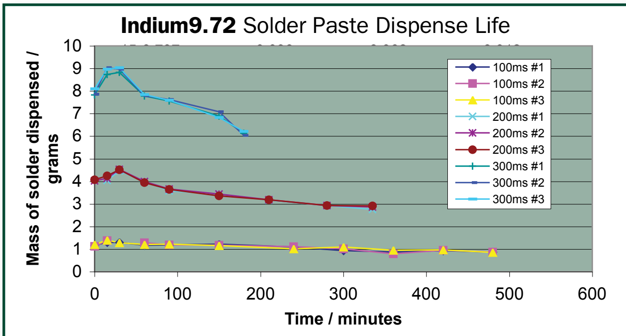
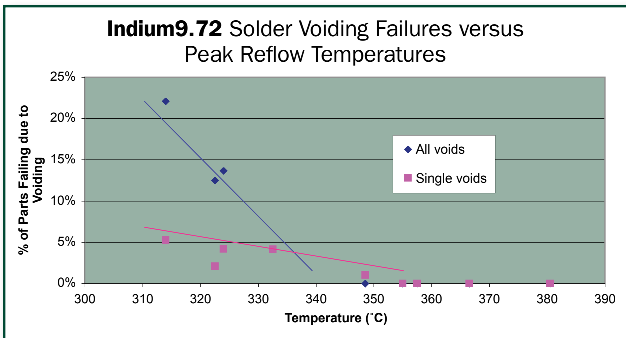


Figure 2



Application Note: Voiding

Voiding is a function of many different parameters in the process, as can be seen from the voiding diagram (see Fig. 3). Die-attach solder paste should be handled carefully, particularly with high-Pb pastes, which are more sensitive to storage at ambient temperatures. The reflow atmosphere diagram (see Fig. 4) illustrates typical atmosphere needs for high-temperature reflow processes.

Die-Attach Solder Paste Alloys

Pb-free:	Solidus	Liquidus	Comments
Indalloy 121 (96.5Sn/3.5Ag)	221˚C Eutectic		Automotive usage
Indalloy 133 (95.0Sn/5.0Sb)	235˚C	240˚C	Contains antimony
Indalloy 209 (65.0Sn/25.0Ag/10.0Sb)	233˚C Eutectic		J Alloy: contains antimony
Pb-based:	**Solidus**	**Liquidus**	**Comments**
Indalloy 150 (81.0Pb/19.0In)	260˚C	275˚C	Good thermal cycling
Indalloy 151 (5.0Sn/92.5Pb/2.5Ag)	287˚C	296˚C	Industry standard for solder paste
Indalloy 159 (10.0Sn/90.0Pb)	275˚C	302˚C	Automotive
Indalloy 163 (2.0Sn/95.5Pb/2.5Ag)	299˚C	304˚C	Wire alloy, low Sn
Indalloy 164 (5.0In/92.5Pb/2.5Ag)	300˚C	310˚C	Good thermal cycling
Indalloy 165 (1.0Sn/97.5Pb/1.5Ag)	309˚C Eutectic		Wire alloy, low Sn
Indalloy 171 (5.0Sn/95.0Pb)	308˚C	312˚C	Automotive, wire
Indalloy 228 (10.0Sn/88.0Pb/2.0Ag)	268˚C	290˚C	Poor thermal cycling
Indalloy 233 (5.0Sn/85.0Pb/10.0Sb)	240˚C	256˚C	Step soldering usage

Factors Affecting Voiding

Figure 3

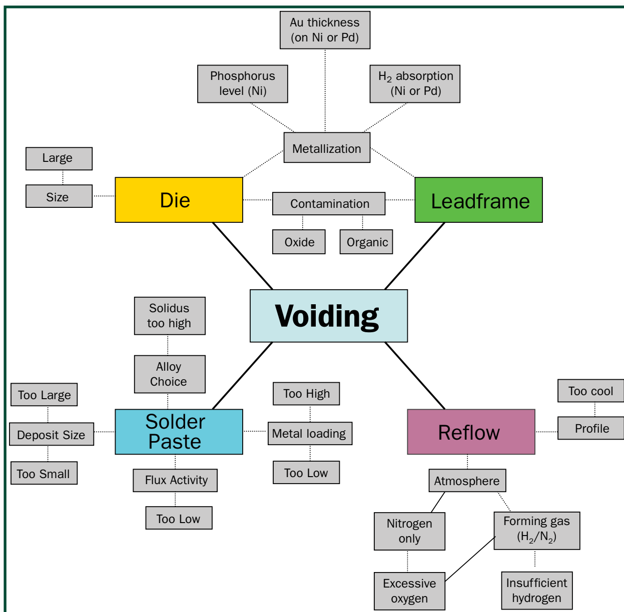
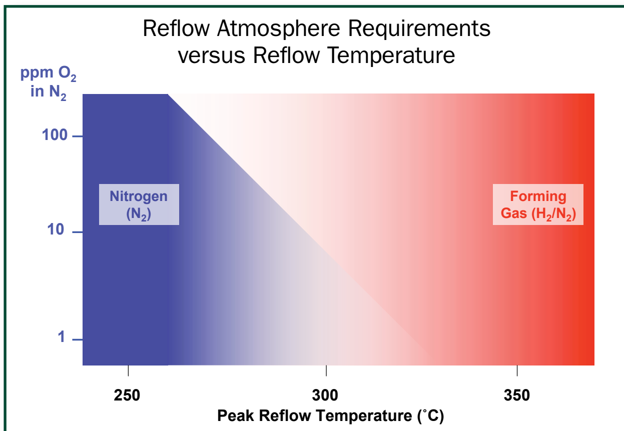


Figure 4



Die-Attach Wire

Introduction

Indium Corporation's **Die-Attach Wire** (or SSDA [soft solder die-attach] wire) is a fluxless solder wire used to effect die-attach. SSDA grade wire will result in higher yields of an improved quality product with fewer interruptions in production.

Key Performance Needs:

- Ultralow oxide (wire surface and in wire)
- High alloy purity
- Precise and consistent wire diameter
- Tight alloy chemistry control

Application Note: SSDA Wire versus Standard Grade Wire

Indium SSDA grade solder wire differs from standard grade solder wire in three principal ways:

First, elements with a purity ≥99.95% are used to produce Indium Corporation SSDA wire alloys. This wire proves to be among the highest purity in the industry by actual comparative analysis. This assures that the alloy melts without producing slag (from various impurities), to deliver more uniform wetting. Further, there is no clogging of the spanker or buildup of slag in other areas, minimizing interruptions in production.

Second, the oxide content on the SSDA wires surface and interior is minimal. This is achieved by a combination of the use of high purity raw materials, as discussed above, but also by inert gas, shielding of the process, particularly during the spooling of the final package. The spool is then sealed in a metallic envelope, also under inert gas, to prevent diffusion of air into the package during storage. A clean, oxide-free wire allows smooth production of molten solder that wets better and more uniformly, consistently producing nearly void-free solder joints.

Third, and finally, the use of an inert gas-shielded extrusion process, monitored with laser micrometers, allows production of Indium SSDA wire of 30 mil (+0.762 mm) diameter with a maximum variance of only 0.786 mil (+0.02 mm), compared to the variance of standard wire, which is typically +2mil (+0.05mm).

Standard Wire Diameters

Diameter*	Tolerance
0.762mm (0.030 inch)	+/ 0.020mm (0.008 inch)
0.508mm (0.020 inch)	+/ 0.020mm (0.008 inch)
0.381mm (0.015 inch)	+/ 0.020mm (0.008 inch)

** Indium Corporation is a custom manufacturer: smaller and larger diameters are available.*

Alloys for Die-Attach Solder Wire

Pb-free:	Solidus	Liquidus	Comments
Indalloy 133 (95.0Sn/5.0Sb)	235°C	240°C	Contains antimony
Indalloy 209 (65.0Sn/25.0Ag/10.0Sb)	233°C Eutectic		J alloy: contains antimony
Pb-based:	**Solidus**	**Liquidus**	**Comments**
Indalloy 150 (81.0Pb/19.0In)	260°C	275°C	Good thermal cycling
Indalloy 151 (5.0Sn/92.5Pb/2.5Ag)	287°C	296°C	Industry standard for solder paste
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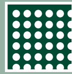
Indalloy 164 (5.0In/92.5Pb/2.5Ag)	300°C	310°C	Good thermal cycling
Indalloy 165 (1.0Sn/97.5Pb/1.5Ag)	309°C Eutectic		Wire alloy, low Sn
Indalloy 171 (5.0Sn/95.0Pb)	308°C	312°C	Automotive, wire
Indalloy 228 (10.0Sn/88.0Pb/2.0Ag)	268°C	290°C	Poor thermal cycling



Metal Thermal Interface Materials

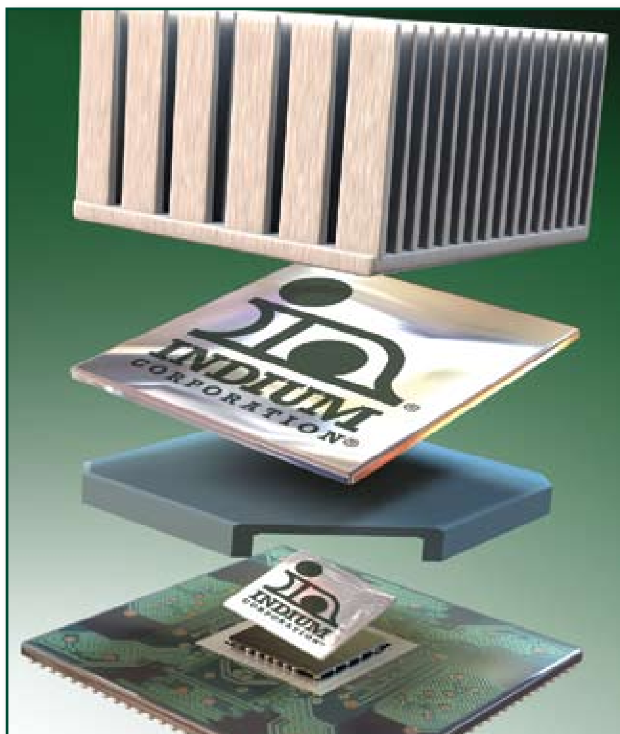
Introduction

Metal Thermal Interface Materials radically improve:

- Heat dissipation efficiency in electronic devices
- Thermal conductance for high power devices with power densities in excess of 50W/cm^2
- End-of-life performance at the thermal interface – to avoid failures common with fluidic solutions such as greases
- Portable device battery performance – by reducing thermal resistance and cooling fan size
- Portable device use profile – by reducing heatsink size and mass
- Compliance with RoHS while accommodating step soldering requirements

Indium Corporation has solutions for:

- Telecom
- Computing
- Semiconductors
- LEDs
- Photonics
- Medical
- Cryogenics
- Automotives
- Power devices



Applications

Some non-confidential applications include:

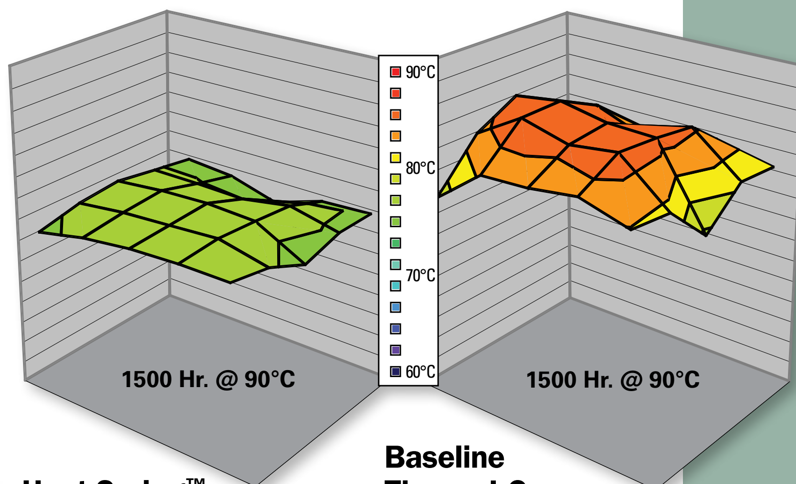
- Semiconductor integrated circuits
- Power QFNs
- Power device to PCB attach (TO220, etc.)
- Telecom
- Die-Attach (Photonics, MOSFETS, LED etc.)
- Laser diodes

Products

- Au/Sn solder
- In/Pb solders
- Pure In
- InFORMS®
- Sn/Pb solders
- SAC Pb-Free solders

Packaging

- Tape & Reel
- Syringe
- Bottle
- Custom packaging



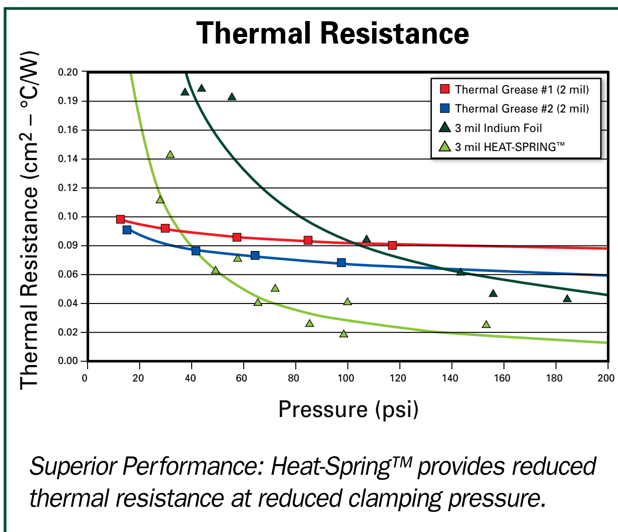
Heat-Spring™
(Device runs cooler)

Baseline Thermal Grease
(Device runs hotter)

Lower temperatures confirm the superiority of Indium Corporation's Heat-Spring™ TIM vs. thermal grease.

Metal Properties

Material	Indalloy Number	Thermal Conductivity (W/mK)	Liquidus (°C)	Solidus (°C)
100In	4	86	157 (mp)	157 (mp)
97In/3Ag	290	73	143 (Eutectic)	
90In/10Ag	3	67	237	143
91Sn/9Zn	201	61	199 (Eutectic)	
52In/48Sn	1E	34	118 (Eutectic)	



Superior Performance: Heat-Spring™ provides reduced thermal resistance at reduced clamping pressure.

Types of Metal TIMs:

1. Solderable
2. Compressible
3. Liquid
4. Low-Melting Alloy

Solder Spheres

Introduction

Indium Corporation produces spheres with accurate diameters; shiny surface finishes; and highly spherical shapes. Our spheres are made in dedicated manufacturing cells supported by Statistical Process Controls (SPC).

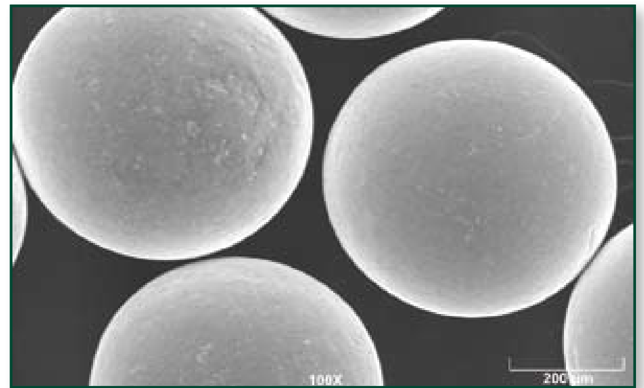
All spheres are made from pure metals, combined to produce exact alloy compositions. After forming, spheres are classified by size using an automated, high capacity process that results in smooth, bright surfaces.

Key Performance Needs:

- High purity alloy
- Roundness (sphericality)
- Accurate diameter
- Non-clumping
- Non-darkening

Standard Solder Materials:

- 99.99% In
- 63.0Sn/37.0Pb
- 62.0Sn/36.0Pb/2.0Ag
- SAC405: 95.5Sn/4.0Ag/0.5Cu
- SAC305: 96.5Sn/3.0Ag/0.5Cu
- SAC387: 96.5Sn/3.8Ag/0.7Cu



Advantages

Indium Corporation solder spheres are used by Semiconductor Packaging companies around the world. Our customers tell us that we offer the following advantages over competitor solder spheres:

- Consistent shininess allows ease of automated inspection
- Use of pure alloy guarantees consistent reflow and wetting
- Copper limits tighter than J-STD-004 for SAC alloys
- Homogeneity of alloy within each solder sphere, from our unique manufacturing process

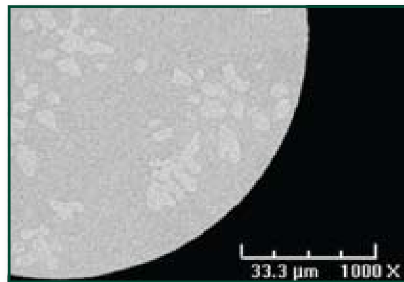
Standard Sizes:

- 0.300mm (12mil) to 0.760mm (30mil)

Microspheres

Microspheres are solder spheres that have a diameter of 0.3mm (12mils) or less. These are finding a variety of niche applications in areas as diverse as MEMS; LEDs; and increasingly in wafer-level packaging.

Our capabilities include the manufacture of spheres of almost any alloy (including Au/Sn) down to 0.1mm in diameter, at an unmatched tolerance of +/- 5%. Figure 1 shows 4mil diameter gold/tin eutectic spheres. Figure 2 shows our ability to meet the tolerance needs of our most demanding customers.



Microspheres	
Product	**Application**
In (99.99%)	Various MEMS
52In/48Sn	Various MEMS
97In/3Ag	WL-CSP (Hi-rel)
80Au/20Sn	MEMS
SAC387	Various
SAC405	WL-CSP (Hi-rel)
SAC-M01	Mobile electronics
SAC-T002	Mobile electronics

Figure 1

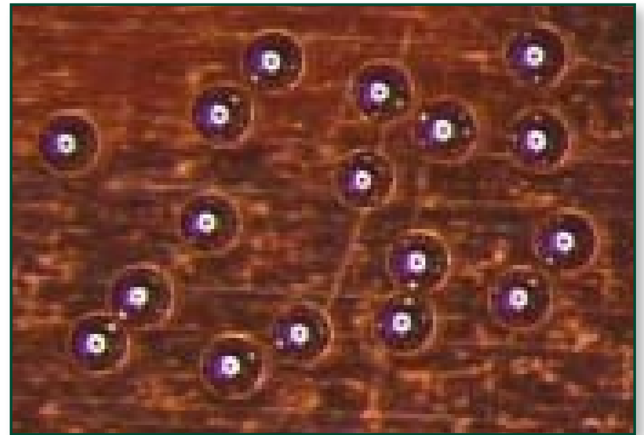
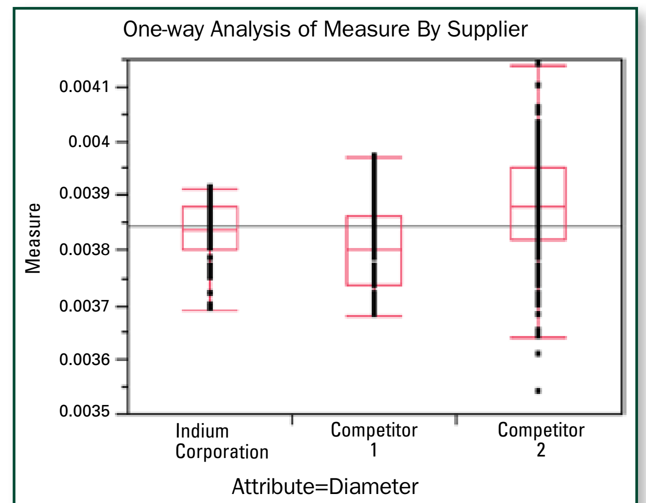
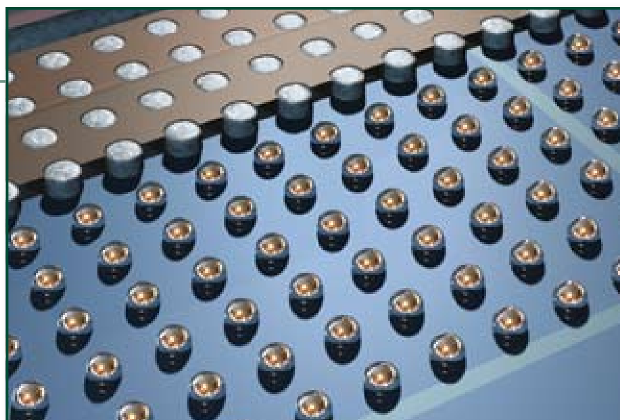


Figure 2



Pastes

Substrate Pastes



Introduction

Indium Corporation's **Substrate Pastes** are nitrogen reflow, no-clean solder pastes made with Type 5 and Type 6 powder, which are specifically formulated for flip-chip attachment and CSP and wafer bumping applications. The flux is compatible with Sn/Ag and Sn/Ag/Cu alloy systems. Sn/Pb is also available. **Substrate Pastes** provide consistent volume deposition, low solder balling, and high yields. If cleaning is needed, the flux residue may be removed with commercially-available cleaners.

Key Performance Needs:

- Ultra fine-pitch printing
- Compatible with all common Sn/Pb and Pb-Free Alloys
- Consistent volume deposition
- Superior yields
- Excellent paste release
- Smooth and shiny joint appearance

Substrate Pastes

Mesh Size	Product	Alloy	Metal Load	Particle Size
Type 5	CP-5241	95.5Sn/3.8Ag/0.7Cu	89-89.5%	15-25 µm
	CP-5246	95.5Sn/4.0Ag/0.5Cu		
	CP-5256	96.5Sn/3.0Ag/0.5Cu		
	CP-5121	96.5Sn/3.5Ag		
	CP-5106	63.0Sn/37.0Pb		
Type 6	CP-6241	95.5Sn/3.8Ag/0.7Cu	89-89.5%	5-15 µm
	CP-6246	95.5Sn/4.0Ag/0.5Cu		
	CP-6256	96.5Sn/3.0Ag/0.5Cu		
	CP-6121	96.5Sn/3.5Ag		
	CP-6106	63.0Sn/37.0Pb		

Eutectic Au/Sn Solder Pastes

Introduction

Eutectic Au/Sn (80Au20Sn) has a melting temperature of 280°C (556°F). It can be made into solder paste form with various options to address specific applications. Au/Sn solder paste is generally used in applications that require a high melting temperature (over 150°C), which requires a hard solder alloy. It is also used in applications that require a high tensile strength and high corrosion resistance, or in step soldering applications where the solder can not melt during a subsequent lower temperature reflow process. For these reasons, Au/Sn solder paste is an ideal solution for military, aerospace, consumer, and medical applications. In addition, Au/Sn solder paste yields are usually above 99.5%.

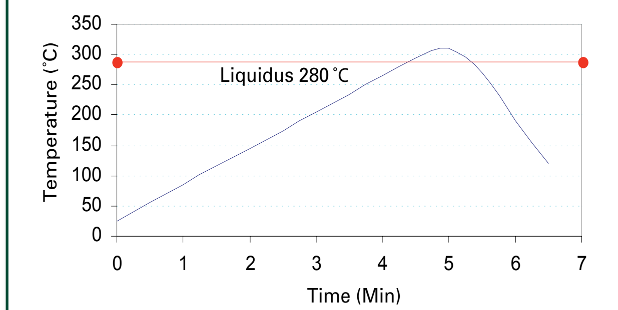
Key Performance Needs:

- High temperature solder
- Maximum solder joint strength
- Compatible with other precious metals
- Superior thermal conductivity when compared to standard solders
- Excellent wetting

Variation of Metal Loading vs. Powder Size

		Adjust Metal Loading By:	
Powder:	**Powder Range (4):**	**Printing**	**Dispensing**
Type 3	25-45 microns	0.0%	0.0%
Type 4	15-38 microns	-0.5%	-0.5%
Type 5	15-25 microns	-0.5%	-1.0%
Type 6	5-15 microns	-1.0%	-1.0%

Recommended Reflow Profile:



Dispensing

Au/Sn solder paste is formulated for automated high-speed, high-reliability, or single- or multi-point dispensing equipment. It also functions well in hand-held applications. Highly accurate volumes can be dispensed using either pneumatic or positive displacement devices. Optimal dispensing performance is dependent on storage conditions, equipment type, and set up.

Eutectic Au/Sn Solder Pastes

			Metal Loading (3)		
Flux:	**Flux Designation (1)**	**Approximate Residue (2)**	**Printing**	**Dispensing**	**Used in**
NC-SMQ 51 SC	ROL1	47%	94%	92%	High power LED; MEMS applications
NC-SMQ 51 A	ROL1	51%	94%	91%	Poor solderability surfaces in die and preform attach
NC-SMQ 75	ORL0	41%	93.5%	90.5%	No-clean applications needing low residue

(1) Per J-STD-004 (2) as % of flux content (3) Will vary with application

Flip-Chip Epoxy Fluxes

Introduction

Epoxy fluxes are designed for use in either Flip-Chip (direct chip attach), chip-scale package (CSP) attach, or ball attach applications. They are applied in applications where partial encapsulation of the finished solder joint is desired, and compatibility with a subsequent capillary underfill is needed. They are therefore intended to be used alongside traditional underfill materials, not as a replacement.

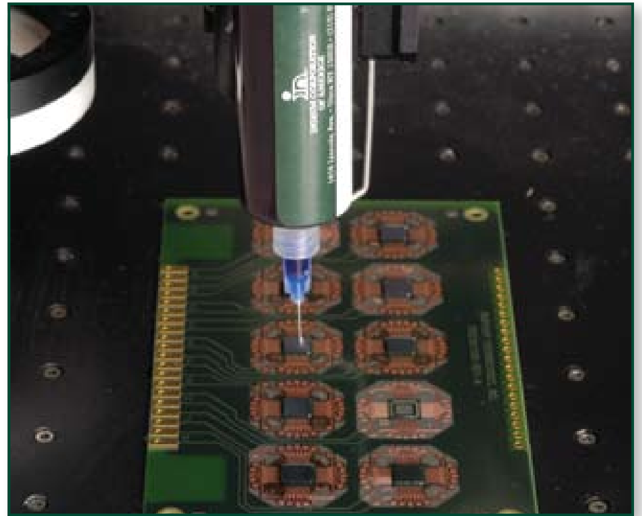
Epoxy fluxes provide two functions: a metal-cleaning flux and an adhesive.

- As fluxes, these materials promote good solderability by cleaning the adjacent metal surfaces.
- As adhesives, they cure after reflow, providing a thermoset polymer layer surrounding the solder connections, providing protection against challenging environments (such as humid or corrosive atmospheres) and also providing reinforcement against lifting of UBM or substrate pads during physical or thermal stressing.

Since the epoxy fluxes are very similar in chemical nature to the most commonly used epoxy underfills, excellent adhesion is maintained between the cured epoxy flux and the underfill material, eliminating issues with delamination.

Key Performance Needs:

- Stable thermoset residue
- Compatible with standard underfill materials
- Compatible with conformal coatings
- Compatible with most finishes and coatings
- Environmentally friendly
- Fast curing



Choosing an Epoxy Flux

Different customers choose different expoxy fluxes for different reasons: some need a high Tg (glass transition temperature), while others need excellent solderability.

Table 1 compares the physical properties of the materials and also includes standard test data. Table 2 shows a comparison of the solderability of a 30mil (0.76mm) diameter SAC305 sphere on a copper coupon after passing through a standard Pb-free reflow profile.

Table 2

Solderability Comparison

Time on 230 ˚C Hotplate	NC Spray Flux	PK001	PK002	PK005
0 secs	68	54	55	59
20 secs	47	0	0	59
1800 secs	0	0	0	53

0 = little or no wetting/spreading
100 = sphere spreads out over substrate metallization

Table 1

Flip Chip Epoxy Flux Physical Properties

Test	PK-001	PK-002	PK-005	Method
Tg / ˚C	85	85	36	TMA (heating rate 10C/min)
CTE (<Tg) / ppm	65	56	52	TMA (heating rate 10C/min)
Viscosity / kcps	20-100	50-250	10-15	Brookfield (Model HB DV11-CP, 0.5rpm)
Typical Tack Strength	140-250 grams	140-250 grams	70-150 grams	Tack Tester (Malcom TK-1)
Shelf-life (-40 ˚C)	6 months	6 months	6 months	Brookfield (Model HB DV11-CP, 0.5rpm)
Pot-life (25 ˚C)	8 hours	8 hours	10 hours	Brookfield (Model HB DV11-CP, 0.5rpm)
Quantitative Halide Content	0%	0%	0%	MIL-STD-883,5011.4
Extractable Ionic Content	<20ppm	<20ppm	<20ppm	MIL-STD-883E
Solid Content	100%	100%	80%	TGA
Flux Residue Compatability	Compatible with underfill	Compatible with underfill	Compatible with underfill	CSAM
Corrosivity	Pass	Pass	Pass	J-STD-004
SIR	>1E8 (Pass)	>1E8 (Pass)	>1E8 (Pass)	J-STD-004

Solder Preforms

Introduction

Solder Preforms deliver precise amounts of solder to specific locations.

Solder Preforms come in standard shapes such as squares, rectangles, washers and discs. Typical sizes range from 0.010” (0.254mm) up to 2” (50.8mm). Smaller and larger sizes, as well as custom shapes, are also available. Dimensions can be held to tight tolerances to assure volume accuracy.

Application Note: Selecting Alloys

Indium Corporation offers a wide assortment of alloys with liquidus temperatures that range from 47°C to 1063°C. Alloys can be In–containing, Au-containing, Pb–Free, fusible, or standard Sn/Pb, as well as many others.

Alloy selection should be based on strength and other required physical properties, as well as the preferred soldering temperature and the operating temperature of the device being soldered. A general rule is to select an alloy that melts at least 50°C higher than the operational temperature of the part being soldered.

Next, consider the materials being soldered and which solder is most compatible with them. For example, Sn–based solders will scavenge the gold from Au-plated parts, forming brittle intermetallics, so In-based solders are generally recommended in these cases.

Metals and alloys have different characteristics that can affect the ease with which they can be made into different shapes and thicknesses. It is important to consider the shape of the final preform in the alloy selection process.

The operating environment of the completed assembly is also an important consideration for alloy selection. Will it operate in very high or very low temperatures, or be subjected to vibration? If so, you need to select an alloy that will stand up to these conditions.

Our Application Engineers work with you to determine the best alloy for your application.

Application Note: Selecting Dimensions

The location of the solder joint and the volume of solder needed will determine the size and shape of the preform. Once the flat dimensions (diameter, length, width) have been determined, the thickness can be adjusted to achieve the desired volume of solder. Generally, for through–hole connections, add 10–20% to the calculated barrel volume for a good fillet. For pad to pad joints, figure about 5% less surface area than the pad.

Each Solder Preform should have a burr tolerance specified. You should stay as close to standard tolerances as possible to avoid adding cost and lead time to your preforms.

Indium Corporation has an extensive library of sizes and shapes from which you can choose, or we can create a set–up specifically for your application. Using an existing preform size can eliminate the additional time and cost associated with creating a new set–up.

Dimensional Specification

Width/Length or Diameter	Typical Tolerances
Up to 0.100” (2.54mm)	± 0.002”(± 0.051mm)
Over 0.100” (2.54mm)	± 0.005” (± 0.127mm)
Thickness:	
Up to 0.001” (0.025mm)	± 0.0002” (0.005mm)
0.001” (0.025mm) to .002” (0.050mm)	± 0.0003” (0.0076mm)
> 0.002” (0.050mm) to .010” (0.254mm)	± 0.0005” (0.0127mm)
> 0.010” (0.254mm) to .020” (0.508mm)	± 0.0010” (0.0254mm)
> 0.020” (0.508mm) to .050” (1.27mm)	± 0.0025” (0.0635mm)
> 0.050” (1.27mm)	± 5%
Burr Tolerances (Discs, Squares & Rectangles):	
≤ 0.050” (1.27mm)	0.002” (0.050mm)
> 0.050” (1.27mm) to .500” (12.7mm)	0.003” (0.076mm)
> 0.500” (12.7mm)	0.005” (0.127mm)
Burr Tolerances (Washers & Frames):	
≤ 0.100” (2.54mm)	0.003” (0.076mm)
When thickness ≥ 2/3 of I.D.	0.005” (0.127mm)

INDIUM CORPORATION®

Package-on-Package/ System-in-Package Materials

Introduction

Package-on-Package (PoP) and System-in-Package (SiP) are an exciting new technology that allows standard SMT assembly techniques to be used to manufacture combinations of different integrated circuits. For example, different types of memory may be used in combination to provide both DRAM and Flash in the same package for use in a cell phone.

- **PoP Fluxes** are suitable for stacking CBGAs and small PBGAs, which are not subject to flexing.
- **PoP Pastes** are useful when board flexing may occur during reflow, such as larger PBGAs. The presence of a small amount of metal powder allows complete reflowed joints to form, even when the substrate twists and gaps form between the solder sphere and the substrate.

Key Performance Needs:

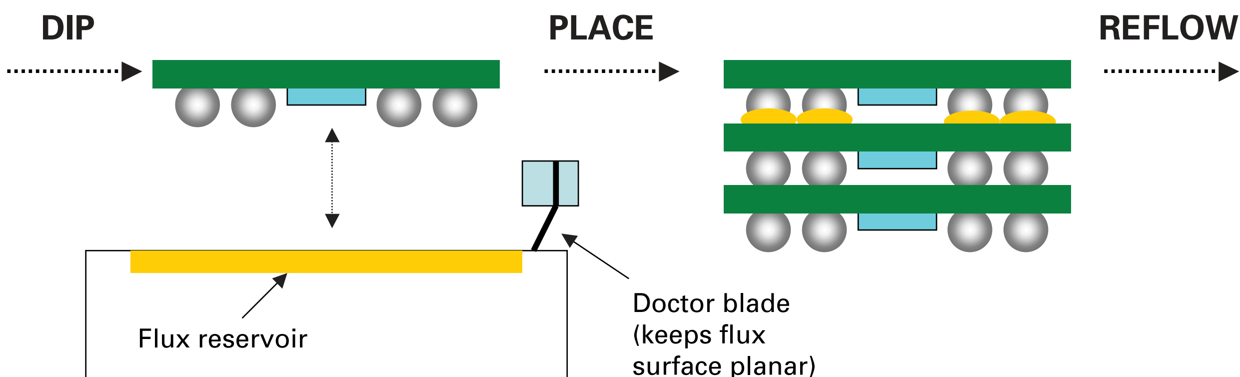
- Particle-, Crystal-, Bubble-Free
- Homogeneous
- Viscosity stable with time
- Pb-Free alloy compatible
- Applied by dipping
- Air reflow
- Wetting onto a variety of metals
- No-clean materials

PoP Flux Properties

Product Name	Flux Designation (1)	~Residue	Reflow
PoP Flux 23LV	ROL1	~50%	Air
PoP Flux 30B	ROL0	~45%	Air
TACFlux® 483	ROL1	~48%	Air/Nitrogen
TACFlux® 010	ROL0	~4%	Nitrogen

(1) Per ANSI/IPC TM650: J-STD-004

Application of PoP Flux



PoP Interconnect Spacers

Introduction

Package-on-Package (PoP) Interconnect Spacers are solder-clad preforms that utilize the strength, melting point, and conductivity of copper for stacking and spacing of BGA packages. Once reflowed, **PoP Interconnect Spacers** transfer signals through substrate layers, just as solder spheres do.

Key Performance Needs:

- Maintain standoff
- Allow multiple reflow cycles and a higher package stack
- Exhibit high thermal and electrical conductivity
- Improve overall assembly strength

Alloys/Materials

- Core material: OFHC copper
  - Annealed per ASTM-B152
  - Tensile strength: 35,000 psi max
  - Other coppers are available upon request

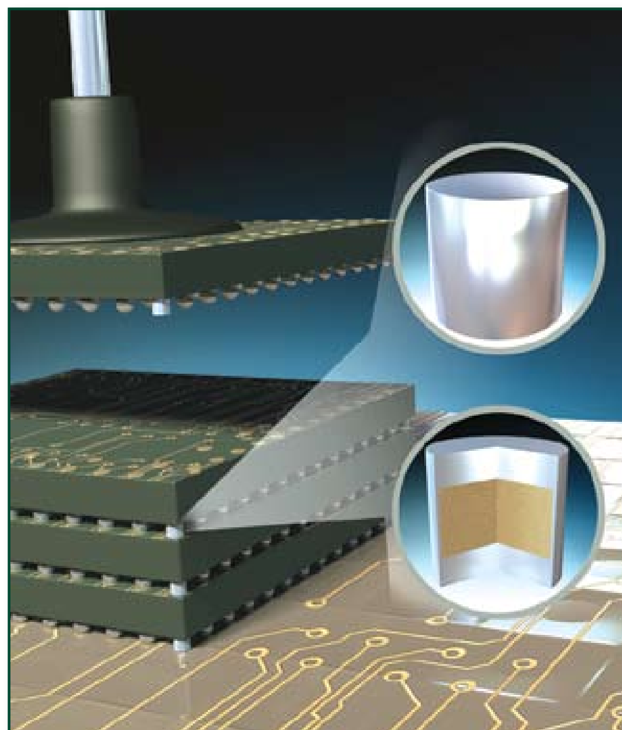
Solder cladding may be matched to the specified sphere composition for uniformity of design.

Solder Cladding Alloys

The most commonly requested solder cladding alloys for package assembly are listed below. Please contact us for other available alloys.

Solder Cladding Alloys

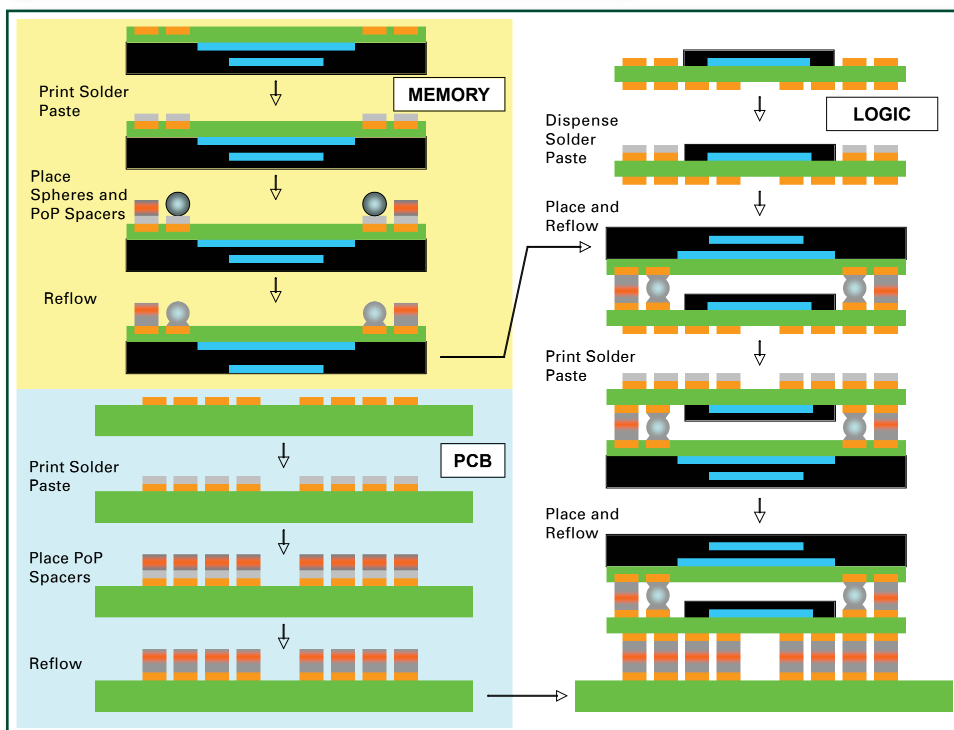
Alloy	Liquidus	Solidus
63.0Sn/37.0Pb	183°C Eutectic	
90.0Pb/10.0Sn	302°C	275°C
95.5Sn/3.8Ag/0.7Cu	220°C	217°C
96.5Sn/3Ag/0.5Cu	220°C	217°C
95.5Sn/4Ag/0.5Cu	220°C	217°C



Packaging

PoP Interconnect Spacers are packaged using the best method to handle the size and strength of the spacer. Common packing methods include jars, boxes (stack pack or layer pack) and tape & reel. Most packages can be backfilled with argon upon request.

When possible, fill each package with the quantity of spacers used in one shift.

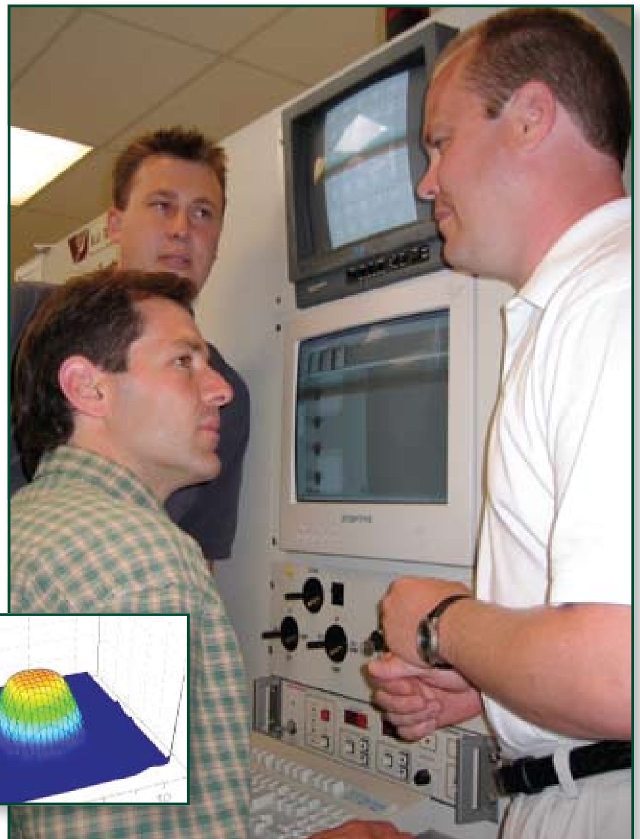


Technical Support

Indium's Process Simulation Lab

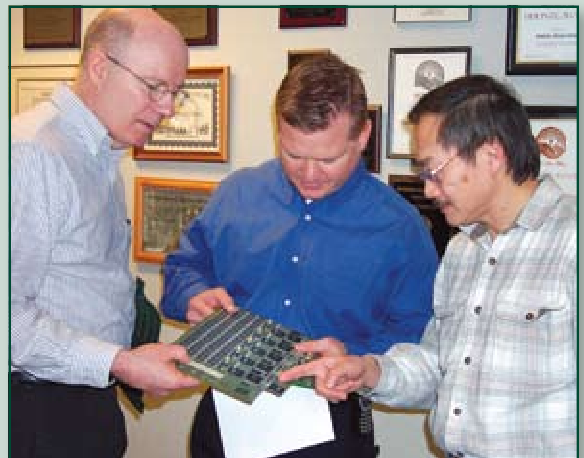
provides Applications Engineers with the tools to work with you and industry partners on designed experiments to fully characterize materials and their use in leading-edge technology applications, including:

- Voiding analysis (x-ray and SAM) of die-attach materials, underfills, and solder joints
- Reflow (up to 360˚C) in a variety of atmospheres
- Dispense and spray applications development
- Microphotography
- Solder sphere and metal (alloy) analysis to PPM levels



Indium's Process Simulation Lab Capabilities:

- Stencil printing
- Precision syringe dispensing
- Fully automated 3D solder paste inspection
- Component placement
- Forced air convection and infrared reflow
- Wave soldering
- X-Ray analysis
- Acoustic microscope inspection
- Temperature-humidity-bias testing (SIR & ECM)
- Mechanical strength testing
- TG/DTA & DSC analysis
- Wetting Balance testing
- Thermal cycling
- And more...



Technical Support—When You Need It.

You have challenges, opportunities, and new processes to address. Indium's technical expertise is available in several forms:

Online Support:
- Powerful, interactive, online technical knowledgebase
- http://knowledge.indium.com
- Available 24/7
- Customer-rated answers

Phone and Email:
- Personal service
- Customized information
- See *semiconductor directory*

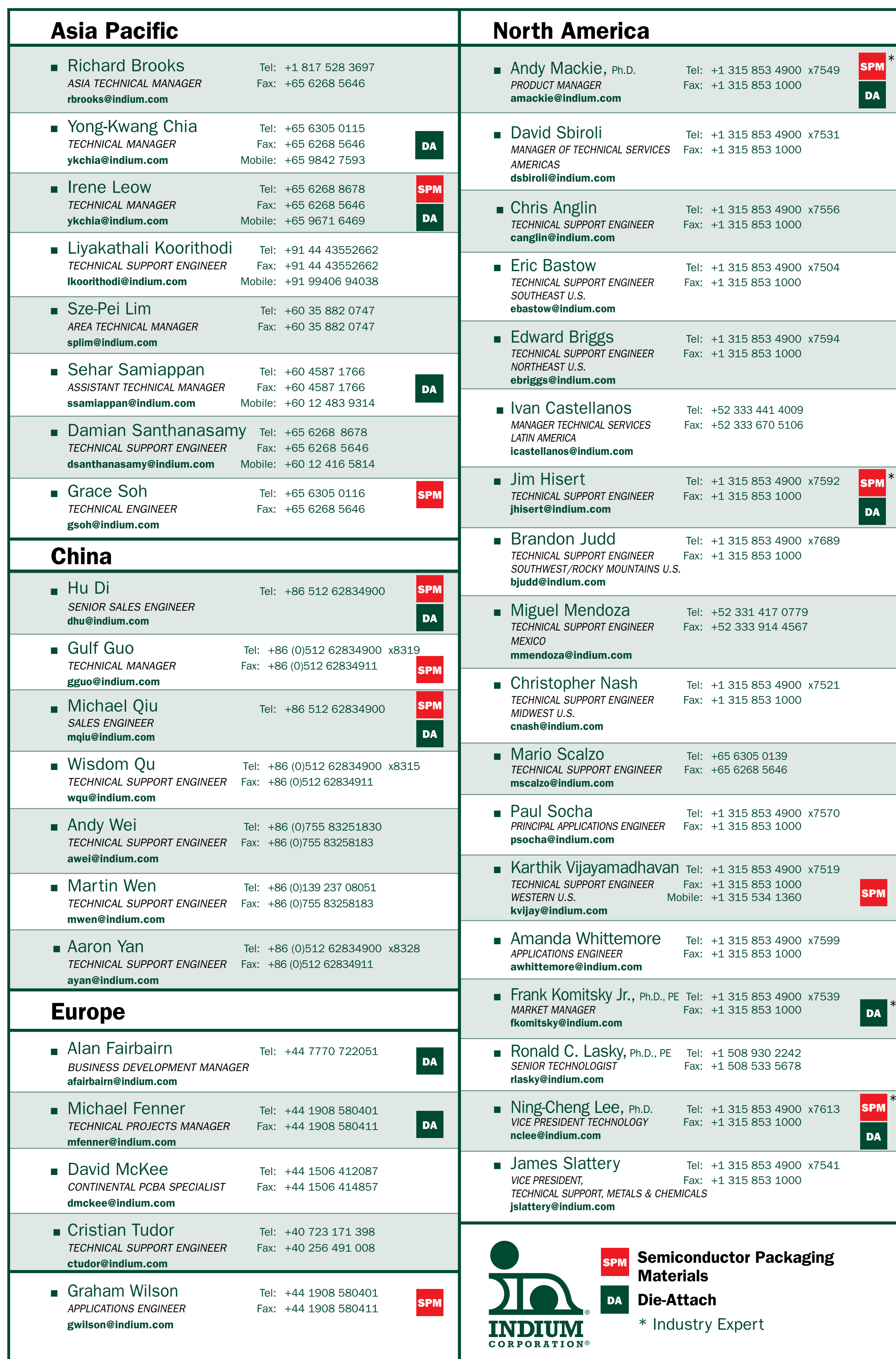
Training Workshops:
- General or specific training
- Your site or off-site
- Customized to meet your needs

Site Visits:
- Total focus on YOUR issues
- Spotlight on your process

Confidentiality

Indium Corporation recognizes the importance of confidentiality in the design of solutions. As a trusted partner, our engineers will work with you to help you find the right solution for your assembly problems. We can help you find the right alloy for performance and the best solder form for ease of assembly.

Semiconductor Support Directory



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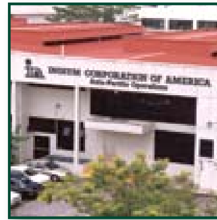
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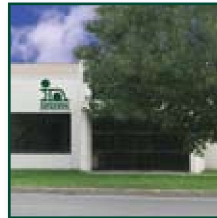
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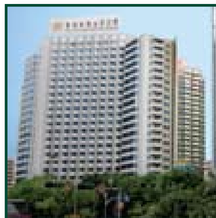
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