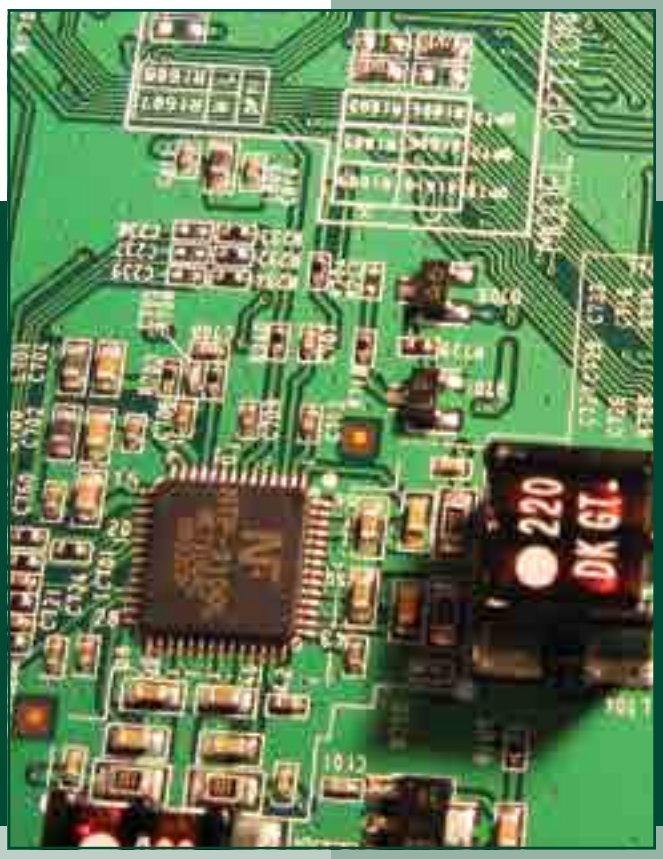
Pb-Free Assembly Materials



Solder Preforms
- Washer
- Rectangle
- Square
- Frame
- Cylinder/Cut Wire
- Disc
- Cluster/Integrated

Solder Pastes
- Halogen-Free
- No-Clean
- Water Wash
- Dispensing
- Pb-Free

Solder Foil & Ribbon
- Indium
- Gold
- Pb-Free

Solder Spheres
- Precision
- High Temperature
- Pb-Free

Ingot & Shot
- Wave Solder
- Fusible Alloys
- Anodes/Plating Ingot
- High-Purity Indium

Metal Gaskets/Seals
- O-Rings
- Flat Gaskets
- Custom Shapes

Metal TIMs
- Metal Shims
- Compressible Metals
- Liquid Metals

Solder Fluxes
- Wave
- TACFlux™
- Flip-Chip Flux

Solder Wire
- Solid
- Flux-Cored
- Die-Attach

Polymers/ Underfills
- No-Flow Underfill
- Epoxy Flux

Solar
- Metallization Pastes
- Sputtering Targets
- Evaporation Sources
- In/Ga Chemicals
- Alloy Powders
- Tabbing Conductors

Other Brochures Available:

- **Semiconductor Packaging**
- **Engineered Solders**
- **Thermal Interface Materials**

INDIUM® CORPORATION®

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15 Wave Solder Fluxes

16 Rework, Repair, and Touch-Up Materials

17 Advanced Technology Package-on-Package

18 Technical Support

19 Research Labs

A **QR** (quick response) **code** contains encoded data.

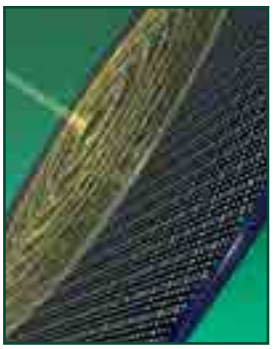
When scanned with a smart phone's camera (via a QR reader application), it will take you to a specific URL or text message.

PCB Assembly

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

Semiconductor Packaging

- Bump fusion wafer fluxes
- Flip-chip fluxes
- TIM: 1, 1.5, burn-in
- Substrate bumping
- Ball attach



Engineered Solders

- Fluxless die-attach
- Hermetic sealing
- Pin soldering
- Other speciality

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/m•K conductivity
- Accommodates CTE mismatch

Pb-Free Alloy Selection

Choosing an Alloy

1. Final assembly operating conditions (temperature & stresses):

- To eliminate thermal failure (melting of joint), the alloy softening point (solidus) should be 40° – 50°C above operating temperature.
- Mechanical stresses induced by temperature fluctuations must be matched by alloy compliance (thermal fatigue resistance).
- Hostile environments, such as salt or swamp conditions, may require corrosion resistant alloys.

2. Surface metallization (alloy compatibility):

- The alloy must wet to surfaces while not scavenging (dissolving) excessive surface metal or forming brittle intermetallics.
- Typical surface metal is gold (Au) over nickel (Ni). Recommended gold thickness is generally between 8 – 15 micro inches (2,000 – 4,000 angstroms). If Au thickness is greater than 8 – 15 micro inches, a non Sn-bearing alloy may be needed to avoid brittle AuSn intermetallics.

3. Assembly conditions and methods:

- Most alloys will form a solder joint best at temperatures 20° – 40°C above the alloy's liquidus point. Consequently, the peak temperature limitations of components must be considered.
- Heating methods could impact the alloy choice. For example, a fluxless process with no reducing atmosphere may require an alloy that has low oxide formation, such as 80Au20Sn.

4. Fabrication capabilities:

- All alloys cannot be formed into all shapes and sizes. For example, 58Bi42Sn is an excellent low temperature alloy, but its brittle nature makes the formation of fine wire difficult.
- Key variables that impact fabrication: brittleness (low malleability and ductility); oxide formation rate; melting temperature; segregation; and softness.

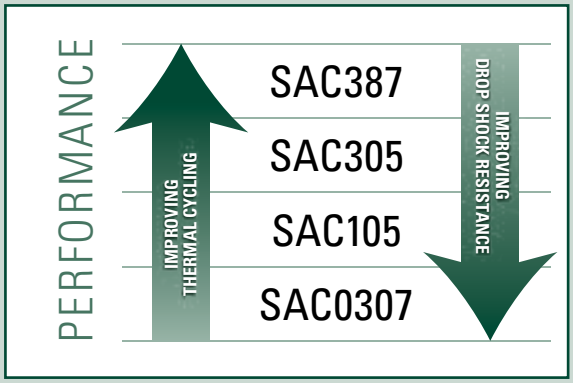
5. Cost:

- Alloy elemental composition can be an issue. For instance Au, Ag, and In alloys can be expensive.
- Costs will vary due to fabrication difficulties and the quantity ordered.

Pb-Free Alloy Reliability

Ag_3Sn Platelet Formation in High Ag SAC Alloys

Source: T. Y. Lee, W. J. Choi, K. N. Tu, J. W. Jang, S. M. Kuo, J. K. Lin, D. R. Frear, K. Zeng, J. K. Kivilahti, "Morphology, kinetics, and thermodynamics of solid-state aging of eutectic SnPb and Pb-free solders (Sn-3.5 Ag, Sn-3.8 Ag-0.7 Cu and Sn-0.7 Cu) on Cu," J. Mater. Res., 17, 291-301 (2002).



Popular Pb-Free Alloys

Composition	Solidus (°C)	Liquidus (°C)	Comments
52.0In/48.0Sn	118 (eutectic)		Lowest melting point practical solder.
58.0Bi/42.0Sn	138 (eutectic)		Good thermal fatigue performance; established history.
57.0Bi/42.0Sn/1.0Ag	139	140	Ag addition makes this alloy less brittle than 58.0Bi/42.0Sn.
77.2Sn/20.0In/2.8Ag	175	187	Not for use over 100°C due to 118°C Sn/In eutectic.
86.9Sn/10.0In/3.1Ag	204	205	No Sn/In eutectic problem; potential use for flip-chip assembly.
91.8Sn/4.8Bi/3.4Ag	211	213	Board and component metallizations must be Pb-free.
95.5Sn/4.0Ag/0.5Cu (SAC405)	217	218	Petzow (German) prior art reference makes this alloy patent-free.
95.5Sn/3.8Ag/0.7Cu (SAC387)	217	219	Original iNEMI recommended SAC alloy.
96.5Sn/3.0Ag/0.5Cu (SAC305)	217	220	Solder products value council recommended alloy.
96.5Sn/3.5Ag	221 (eutectic)		Binary solder has history of use; marginal wetting.
98.5Sn/1.0Ag/0.5Cu (SAC105)	217	225	Low cost alloy with reasonable drop test performance.
98.5Sn/1.0Ag/0.5Cu +Mn (SACM01)	217	225	Drop test performance as good as SnPb.
98.5Sn/1.0Ag/0.5Cu +Ti (SACT)	217	225	Excellent drop test and thermal cycling performance.
99.0Sn/0.3Ag/0.7Cu (SAC0307)	217	227	Low cost SAC alloy.
99.3Sn/0.7Cu	227 (eutectic)		Inexpensive; possible use in wave soldering.
99.5Sn/0.5Cu +Co (Sn995)	227 (eutectic)		High performance and low cost wave solder alloy.
65.0Sn/25.0Ag/10.0Sb	233 (eutectic)		Die-attach solder; very brittle.
95.0Sn/5.0Sb	235	240	High temperature Pb-free alloy.
90.0Sn/10Sb	250	272	High temperature Pb-free alloy.

More on specialty solders & alloys
indium.us/D101

Pb-Free Solder Paste Guide

	Process	Metal Load (T3)	Metal Load (T4)	Flux Class	Halogen-Free (JEITA ET-7304)	Malcom Viscosity (poise)	Typical Tackiness (grams)	Ideal Print Speeds (mm/sec)
Indium8.9	No-clean	88.50	88.25	ROL1	No	2000	50	25 - 100
Indium8.9E	No-clean	88.75	88.50	ROL1	No	1500	35	25 - 150
Indium8.9HF-1	No-clean	89.00	88.50	ROL0	Yes	1300	40	25 - 150
Indium8.9HFA	No-clean	88.50	88.00	ROL0	Yes	1300	50	25 - 200
Indium9.0A	No-clean	88.75	88.50	ROL1	No	1500	35	25 - 150
Indium5.8LS	No-clean	88.50	88.25	ROL0	Yes	1300	40	25 - 200
Indium8.9HF	No-clean	89.00	88.50	ROL0	Yes	1700	35	25 - 150
Indium3.2	Water-wash	88.50	88.00	ORM1	No	1750	50	25 - 50
Indium3.2HF	Water-wash	89.00	88.50	ORH0	Yes	2100	50	25 - 50

	Print Transfer Efficiency	High Print Speeds	BGA/CSP Voiding	QFN Voiding	High Temp Reflow	Graping Resistance	HIP Resistance	In-Circuit Testing
Indium8.9	Good	Good	Better	Better	Best	Better	Best	Better
Indium8.9E	Better	Better	Best	Better	Better	Best	Better	Good
Indium8.9HF-1	Good	Good	Best	Better	Better	Better	Better	Best
Indium8.9HFA	Best	Best	Best	Better	Better	Better	Better	Good
Indium9.0A	Better	Better	Best	Best	Better	Best	Better	Good
Indium5.8LS	Best	Best	Better	Better	Good	Good	Good	Good
Indium8.9HF	Good	Good	Better	Better	Better	Better	Better	Good
Indium3.2	Good	Good	Good	Good	Better	Good	Good	Best
Indium3.2HF	Better	Good	Better	Good	Better	Good	Good	Best

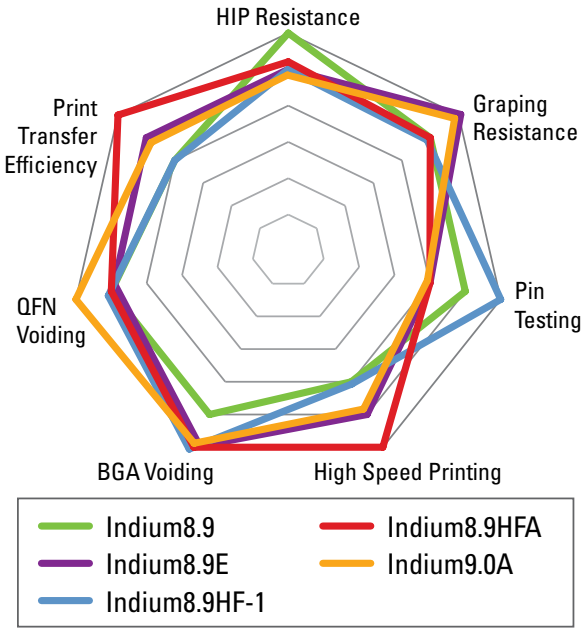
Indium 8.9 Series: Improved Properties for Pb-Free Future

Solder pastes made for the future of electronics

- Ideal performance on miniaturized components
- High quality printing performance:
  - *High transfer efficiency through small apertures (≤0.66AR)*
- Flux vehicles specially designed for the higher processing temperatures required for Pb-free alloy systems
- Air reflow, no-clean solder pastes
- Robust reflow capacity – accommodates a variety of board sizes and profiles

Printing Considerations:

- Stencil design and choice of solder powder are both crucial for optimal printing performance
- When choosing a powder type, select a powder that allows you to maintain a minimum of four solder particles (the largest particles in the range you have chosen) across the smallest aspect of the aperture
- For additional options for solder alloys and powder sizes, see pages 12 and 13 in this brochure



For more on the Indium8.9 series
indium.us/D102

Compatible Products for Indium8.9, Indium8.9E, and Indium9.0A	
Flux-Cored Wire	CW-807
TACFlux™	089
Flux Pen	NC-771

What properties are most important to you?

• Eliminating head-in-pillow	▶ **Indium8.9**
• Eliminating graping	▶ **Indium8.9E**
• In-circuit probe testing	▶ **Indium8.9HF-1**
• Superior printing for miniaturization	▶ **Indium8.9HFA**
• QFN voiding	▶ **Indium9.0A**

Guidelines for Stencil Design

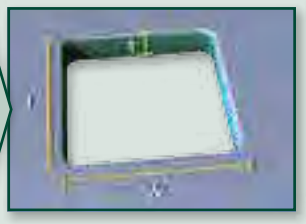
Area Ratio For Square/ Rectangular Apertures

Area Ratio = $\frac{\text{Area Opening}}{\text{Area Walls}}$

Area Opening = $L \times W$

Area Walls = $2t(L + W)$

Area Ratio = $\frac{L \times W}{2t(L + W)}$



Area Ratio For Circular Apertures

Area Ratio = $\frac{\text{Area Opening}}{\text{Area Walls}}$

Area Opening = $\frac{\pi D^2}{4}$

Area Walls = πDt

Area Ratio = $\frac{D}{4t}$

Sample Area Ratio Chart

Pad Size (mm)	0.05	0.10	0.15	01005	0.20	0.25	0201	0.30	0.35	0.40	0.45	0.50
Aperture Width (mil)	**2.00**	**3.90**	**5.90**	**7 x 8**	**7.90**	**9.80**	**10 x 12**	**11.80**	**13.80**	**15.70**	**17.70**	**19.70**
Stencil Thickness (5.0 mil)	0.10	0.20	0.30	0.37	0.39	0.49	0.55	0.59	0.69	0.79	0.89	0.98
Stencil Thickness (4.5 mil)	0.11	0.22	0.33	0.41	0.44	0.55	0.61	0.66	0.77	0.87	0.98	1.09
Stencil Thickness (4.0 mil)	0.12	0.25	0.37	0.47	0.49	0.62	0.68	0.74	0.86	0.98	1.11	1.23
Stencil Thickness (3.5 mil)	0.14	0.28	0.42	0.53	0.56	0.70	0.78	0.84	0.98	1.12	1.27	1.41
Stencil Thickness (3.0 mil)	0.16	0.33	0.49	0.62	0.66	0.82	0.91	0.98	1.15	1.31	1.48	1.64
Stencil Thickness (2.5 mil)	0.20	0.39	0.59	0.75	0.79	0.98	1.09	1.18	1.38	1.57	1.77	1.97

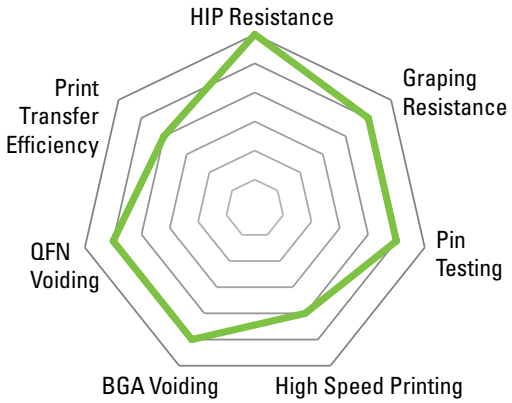
INDIUM CORPORATION®

Indium8.9

“ The Pb-Free solder paste that performs like SnPb!”

“ All of the performance characteristics you have come to expect in a SnPb solder paste.”

To download MSDS and product data sheet
indium.us/D102



UNIQUE FEATURES:

Defect Elimination

- Eliminates head-in-pillow defects. Improves first-pass yields and reduces field failures when mounting BGA devices
- Low voiding. Less than 5% voiding for BGAs with via-in-pad technology, even when using a variety of profiles

Printing

- Designed for CSP, 0201, and 01005 technologies
- Excellent response-to-pause

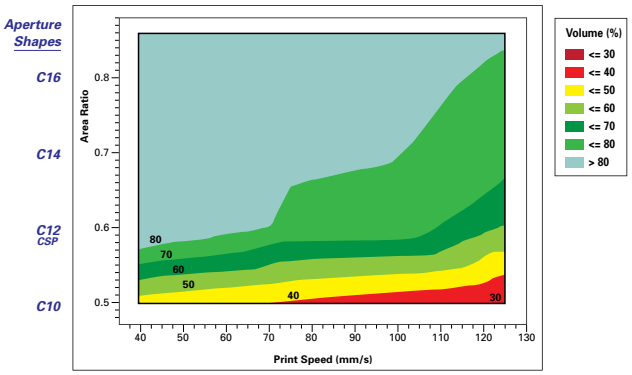
Reflow Capability

- Accommodates high peak temperatures and long soak profiles
- Excellent wetting to all common finishes at high and low peak reflow temperatures

In-Circuit Probe Testing

- Clear, probe-testable flux residue
- Fewer false rejects due to Indium8.9’s thermal stability, maintaining soft, pliable residues even after multiple reflows

Actual Print Transfer Efficiency for Different Apertures and Print Speeds



The Solution for Head-in-Pillow Defects

What is head-in-pillow?

- A defect in which both the solder paste and the BGA ball reflow but they do not coalesce

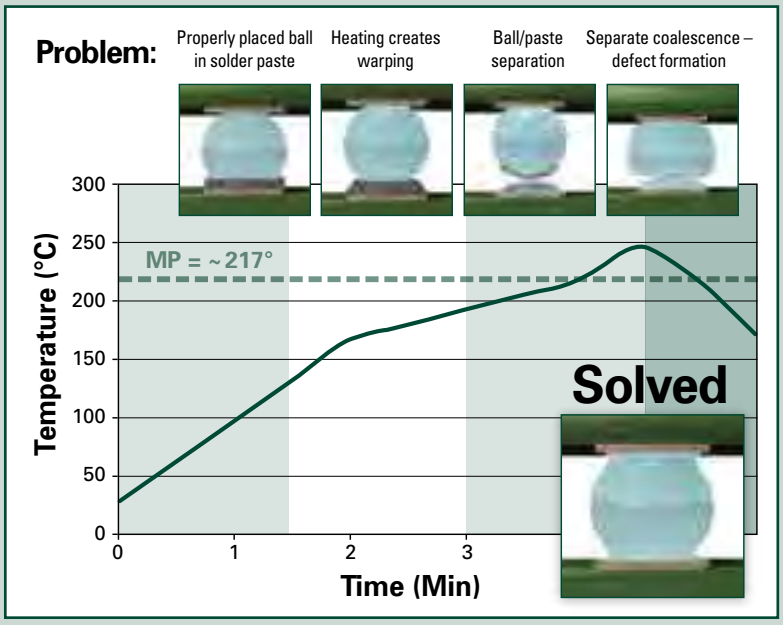
How does it happen?

1. Component warps during preheat and soak of profile
2. Paste and ball separate prior to melting
3. Paste and ball melt separately and solidify separately
4. Oxide layer forms on surface of molten solder
5. Component warps back during cool down but has already solidified or oxide layer is too thick for paste and ball to coalesce.

How does Indium8.9 eliminate head-in-pillow?

- Excellent wetting properties help to join paste and ball upon reflow
- Strong oxidation barrier promotes coalescence
- High tackiness prevents the ball and paste from separating

Head-in-Pillow Defect Formation



Indium8.9E

“Best-in-class for small deposit print transfer efficiency and elimination of graping defects.”

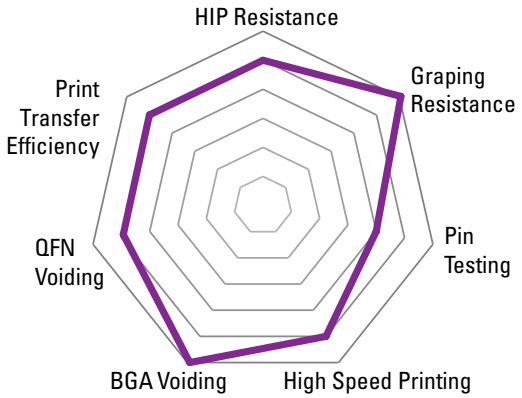
UNIQUE FEATURES:

Defect elimination

- Solves graping defects by inhibiting oxidation during long reflow and promoting coalescence
- Low voiding for BGAs and CSPs
- Reduced head-in-pillow defects

Printing

- Offers great print transfer efficiency in the broadest range of processes
- Ideal for small deposits
- Designed for CSP, 0201, and 01005 technologies
- Excellent response-to-pause



To download MSDS and product data sheet
indium.us/D102

The Solution for Graping Defects

What is graping?

Solder powder oxide prevents proper coalescence. It looks like a bunch of grapes on top of the solder joint

How does it happen?

1. Smaller paste deposits result in a higher relative surface area of exposed solder particles (and smaller particle sizes)
2. Higher temperatures and longer profiles required for Pb-free soldering
3. Premature flux spreading, leading to exposed particles that oxidize before peak temperature

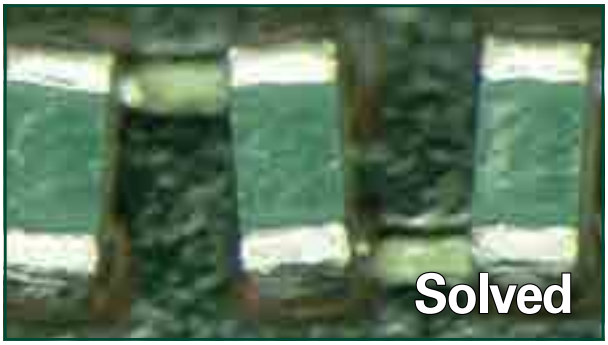
How does Indium8.9E eliminate graping?

- Appropriate flux chemistry reduces premature flux spread
- Unique oxidation barrier technology

Be careful – graping is often misdiagnosed as cold solder.

Additional approaches to eliminate graping:

- Maximize aperture dimensions within known stencil design rules to insure the maximum deposited paste volume
- Use electro-form or electro-polished stencils
- Optimize aperture profile to enable maximum paste release (e.g. trapezoid aperture)
- Set the highest possible separation speed to maximize paste release
- Consider changes to reflow profile to minimize soak time



Causes of Graping			
Reflow	**Printing**	**Materials**	**Processes**
Ramp rate	Stencil thickness	Solder paste oxidation resistance	Contaminated incoming air
Soak time	Aperture size	Powder size	Time between print and reflow
Peak temperature	Transfer efficiency	PCB surface finish and solderability	Aperture clogging
Air flow rate in reflow oven		Component finish and solderability	Paste time on stencil
			Poor paste handling or storage

What Does "Halogen-Free" Really Mean?

For more on this topic
indium.us/D103

Minimize Environmental Impact

Upon incineration, some organic halogenated compounds are known to release toxic dioxins and furans into the environment.

Ensuring that Indium Products are Halogen-Free:

- Products tested with EN14582 test method
  - *Oxygen bomb combustion followed by ion chromatography*
  - *Assures that halogens will not be released by reflow or recycling*

Sources of halogens in electronics:

- Solder pastes
- Fluxes
- PCB laminate materials
- Components
- Cables

Halogen-free products:

- Solder pastes
- Wave fluxes
- Cored wire
- Rework fluxes

www.Halogen-Free.com

- Test methods
- Environmental and legislative information
- Informative blogs
- Latest news

FACT

Ion Chromatography and Titration Do Not Guarantee Halogen-Free

Both ion chromatography and titration only reveal the presence of ionic halide content in materials, although additional halogen content can be present covalently bonded within the formulation. These covalently bonded halogens may be restricted by legislation and may pose an environmental risk during the recycling process.

The designation of "L0" per IPC J-STD-004 does not indicate that materials are halogen-free; this merely indicates that ionic halide content is less than 500ppm.

METHOD

Oxygen Bomb Combustion Followed by Ion Chromatography (EN14582)

Most of the electronics manufacturing industry agrees that the best method for determining the halogen content of a flux or solder paste is through the use of an oxygen bomb combustion followed by ion chromatography (IC) testing.

This test method involves subjecting a sample of flux to an oxygen bomb combustion in which all of the organic material is burned off at very high temperatures. The remaining ash consists of the halogens and other inorganic materials. That ash is then run through ion chromatography to determine the true halogen content. Any covalently bonded halogens would have those bonds broken through the oxygen bomb process.

Indium8.9HF Series

To download MSDS and product data sheet
indium.us/D102

SHARED CHARACTERISTICS:

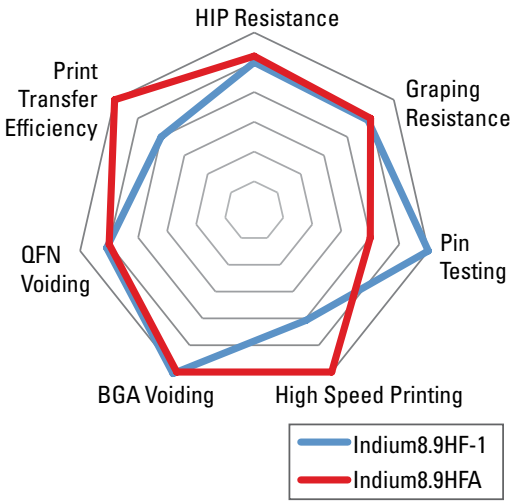
Halogen-free

Unique oxidation barrier technology

- No more head-in-pillow defects
- Strong oxidation barrier eliminates graping
- Low voiding (<5%) for many profiles when soldering BGAs with via-in-pad technology

Robust reflow capability

- Wide processing window accommodates various board sizes, throughput requirements, and minimizes potential defects
- Excellent soldering performance even with high temperatures and long reflow profiles



Compatible Products for Indium8.9HF-1, Indium8.9HFA	
Flux-Cored Wire	CW-802
TACFlux™	020B
Flux Pen	NC-771

Indium8.9HF-1

"A high performance, halogen-free solder paste, designed for best-in-class probe-testability, delivering cost savings and the highest finished goods reliability."

UNIQUE FEATURES:

In-circuit probe testing

- Provides best-in-class probe-testability with few false rejects from in-circuit testing
- Extremely thermally stable; maintains soft, pliable residue, even after reflow

Flux residue from Indium8.9HF-1 does not collect on testing pins

Indium8.9HF-1 **Typical Flux Residue**

In-Circuit Testing (ICT) of Pb-Free Paste Residues		
	ICT fail with marginal resistance (per 1000 boards)	**ICT fail with high resistance** (per 1000 boards)
Typical paste	23	19
Indium8.9HF-1	2	0

Indium8.9HFA

"Superior printing capabilities – great for high speed printing and small apertures."

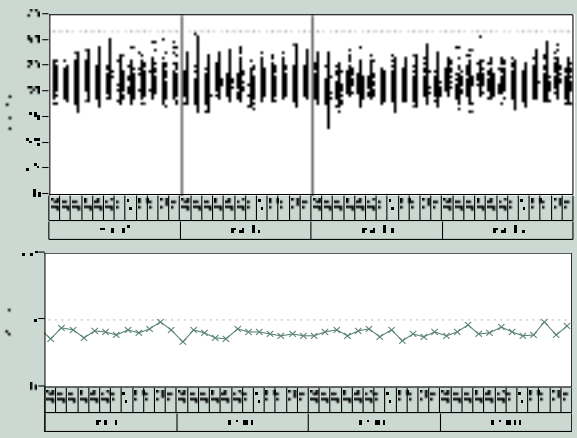
UNIQUE FEATURES:

Printing

- Offers unprecedented print transfer efficiency through small apertures at high print speeds
- Eliminates clogged apertures
- Eliminates hot and cold slump

Indium8.9HFA 0.4mm pitch CSP

CONSISTENT PRINT VOLUMES



Indium9.0A – QFN Voiding

To download MSDS and product data sheet
indium.us/D102

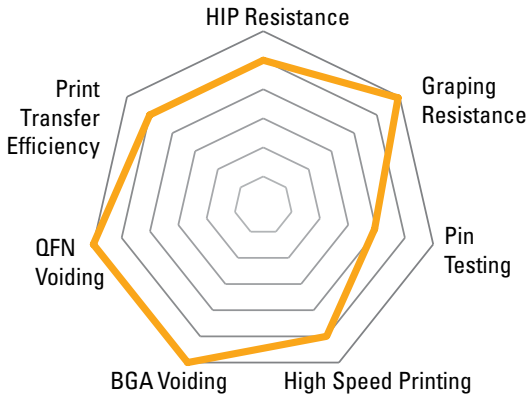
UNIQUE FEATURES:

Defect elimination

- Lowest level of voiding for QFNs, BGAs, and CSPs
- Solves graping defects by inhibiting oxidation during long reflow and promoting coalescence
- Reduced head-in-pillow defects

Printing

- Offers great print transfer efficiency in the broadest range of processes
- Ideal for small deposits



From *"Influence of Reflow Profile and Pb-Free Solder Paste in Minimizing Voids for Quad Flat Pack No-Lead (QFN) Assembly"*

By T. Jensen, E. Briggs, H. Gadepalli, R. Dhanasekaran, and Dr. S. M. Ramkumar

Modified stencil design for thermal pad

Generalized Conclusions:

- *Breaking up the large central aperture into several smaller apertures with a separation between them minimizes overall voiding*
- *Greater aperture separation leaves more room for volatiles to escape, resulting in less vapor trapped and less voids*
- *As paste volume increases, voiding increases. Designing stencils with apertures limiting paste volume will lessen the occurrence of voids*
- *When using larger paste volumes, modified stencil aperture patterns can help to decrease voiding*

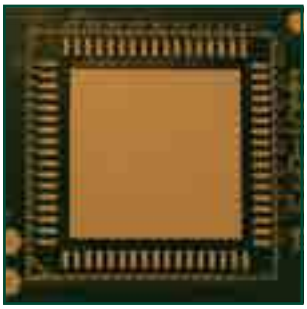
To find this and other technical papers, please visit Indium Corporation's tech library: www.indium.com/techlibrary/whitepapers or simply scan the code at left.

Low Voiding Under QFNs

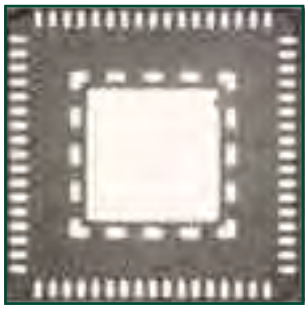
How Indium9.0A provides a solution for voiding

- Increases activity and effectively removes oxide from small solder particles
- Optimized composition of volatile flux components allows for good cleaning of surfaces, while reducing entrapment of gases upon coalescence
- Wide processing window allows for optimization of the reflow profile to further enhance low voiding performance
- Reduces size of the single largest void, and fewer total voids

Avg. Paste Performance	No. of Voids	% Voids	% Largest
Paste A	60	23.95	5.00
Paste B	46	19.20	5.20
Paste C	74	28.62	5.58
Paste D	115	16.90	1.58
Indium9.0A	**31**	**5.11**	**1.84**

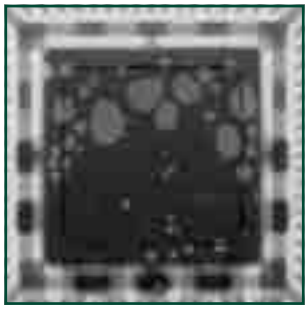


Footprint pattern on board



Component

Voiding with Indium9.0A



Typical voiding (Paste D)

Indium3.2 Water-Soluble Solder Pastes

To download MSDS and product data sheet
indium.us/D102

FEATURES OF INDIUM3.2 AND INDIUM3.2HF

Printing

- Consistent fine-pitch print performance and transfer efficiency
- Excellent response-to-pause
- Tackiness sufficient for high-speed and high-mix SMT assembly
- Outstanding slump resistance

Defect elimination

- Superb wetting performance on a variety of substrates
- Low voiding
- Humidity resistance

Robust reflow capability

- Wide reflow window
- Effective in air or nitrogen environments

Cleaning

- Minimal foaming during cleaning
- Easily cleaned in warm, pressurized DI water
- Enhanced cleaning achieved with hot water or commercially available saponifiers

Indium 3.2HF

- Halogen-free version of Indium3.2

Wetting Comparison on Various Common Substrates

Bare Cu

OSP

ENIG

Immersion Ag

Compatible Products for Indium3.2 and Indium3.2HF	
Flux-Cored Wire	CW-301
TACFlux™	025
Flux Pen	FP-300

Cleaning Under Low-standoff Components

To simulate cleaning under a component, boards were reflowed with a harsher-than-standard reflow profile, providing a worst-case scenario for cleaning. A glass slide was then placed over each board to simulate the top of a BGA or CSP. The board was then cleaned in 25°C water with mild agitation. The pictures (above) are of the same apertures on the same board before and after cleaning.

Indium5.7LT Low Temperature Pb-Free Solder Paste

To download MSDS and product data sheet
indium.us/D102

Indium5.7LT low temperature solder paste

- Formulated specifically for use with BiSn and BiSnAg alloys
- Lower flux activation temperature
- Halogen-free
- Exceptional wetting in air reflow
- Clear residue
- Available for printing and dispensing application
- Particularly useful for attachment of additional components after primary assembly because additional reflow will not cause further cycling of other components

BiSn and BiSnAg Alloys

Bismuth-based alloys are viable for low temperature Pb-free assemblies. They offer mechanical characteristics and reliability comparable to SnPb and better than SAC alloys

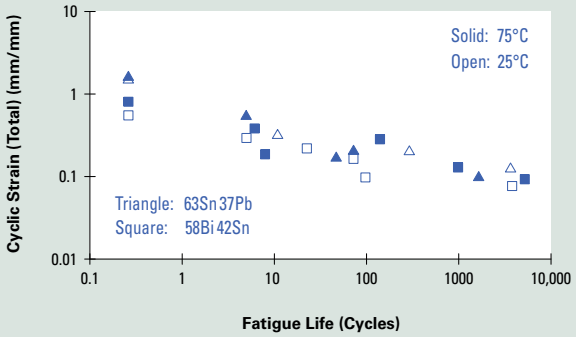
58Bi/42Sn is a eutectic alloy melting at 138°C

- Most suitable for applications with an operating temperature less than 75°C (ex. consumer electronics)
- Compatible with a variety of surface finishes, but best with OSP
- Comparable wetting to lead-containing alloys in both air and nitrogen environments
- Low coefficient of thermal expansion (CTE) thus minimizing CTE mismatches within assembly

57Bi/42Sn/1.0Ag melts at 140°C

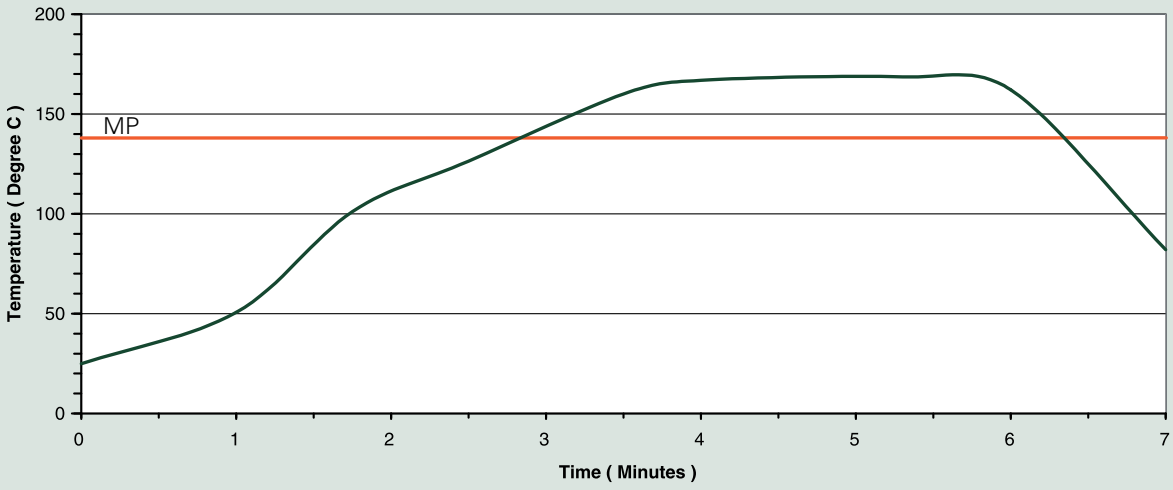
- Addition of silver makes this a more ductile alloy
- Increased thermal fatigue life compared to 58Bi/42Sn
- High strength joints, for instance on a BGA, even when using SAC alloys for the BGA balls

Isothermal shear fatigue similar to SnPb alloy



Source: HP Journal; Z. Mei, H. Holder, and H. Vander Plas

Typical Reflow Profile for Indium5.7LT with BiSn Alloy



Using Preforms to Increase Solder Volume and Reduce Voiding

For more about solder preforms
indium.us/F600

Solder Preforms

- Available in many shapes, sizes, and thicknesses to optimize solder volume
- Packaged in tape & reel for ease of placement
- Wide variety of alloys and range of melting points

Solder Fortification

Miniaturization and the use of thinner stencils leaves some components starved for solder.

Solder fortification:

- Uses preforms with printed paste to add solder volume without using additional flux
- Improves joint strength for large components, such as RF shields
- Enhances reliability for high-use interfaces, such as connectors
- Reduces costs by reducing the need for rework
- Provides consistent volumes of solder

Pin-in-Paste (PiP+)

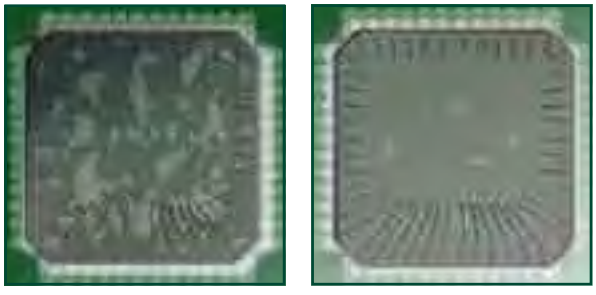
- The "+" is an added solder preform
- Provides precise amounts of solder in an optimal location
- Enhances solder joint strength
- Reduces flux residue by increasing solder volume
- Reduces cost by
  - *Eliminating the need to dispense extra solder paste to increase solder volume*
  - *Utilizing existing process equipment (printer and pick & place machines)*
- Enhances finished goods performance and reliability

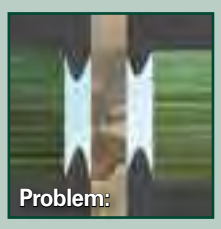
Pin-in-Paste+ Process

1. Print paste next to, and only partially covering, the through-hole
2. Place preform in paste next to through-hole
3. Place through-hole component and reflow normally with assembly

Alternative Approach to Reduce Voiding

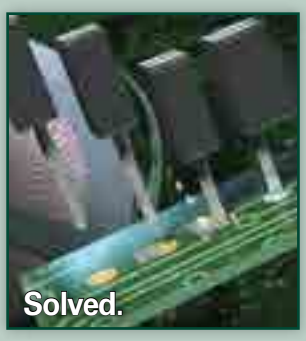
Voiding is partially caused by the volatilization of excess flux. One approach to minimize this effect is to add solder volume without increasing flux volume by using preforms. This is especially effective in large areas, such as under QFNs, where gases are easily entrapped.





- Insufficient Solder Joints
- Excessive Rework
- Additional Process Steps
- False Failures During In-Circuit Testing

Improved Solder Joint Reliability



Wave Solder Technology

Bar Solder

High Purity

- Extremely low impurity levels (see table below to compare with common standards)
- Reduces need for rework
- Optimized for wetting speed
- Improves appearance
- Insures joint strength
- Ingots are packaged in 25lb. boxes for easy ordering

Why Use Sn995 Cobalt-Doped Pb-Free Soldering Alloy?

- Low cost alternative to SAC305, with additional benefits
- Addition of cobalt greatly improves the performance of SnCu alloys
- Cobalt is a more effective dopant than nickel because of its low operating limit, insuring against dopant depletion
- Produces shinier and smoother joints than SAC305 or SnCu alloys
- Drastically reduces dross (see table)

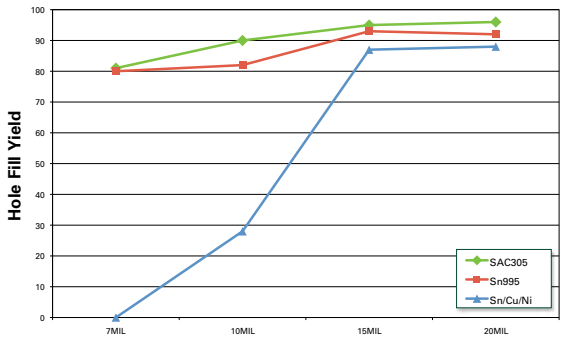
Comparison of Dross Rate at 260°C

	Run Time (hrs)	Dross (g)	Dross Rate
SAC305	19.92	1303.5	65.44g dross/hour
Sn995	**22.28**	**523.3**	**23.49g dross/hour**
SnCuNi	25.00	1357.6	54.30g dross/hour

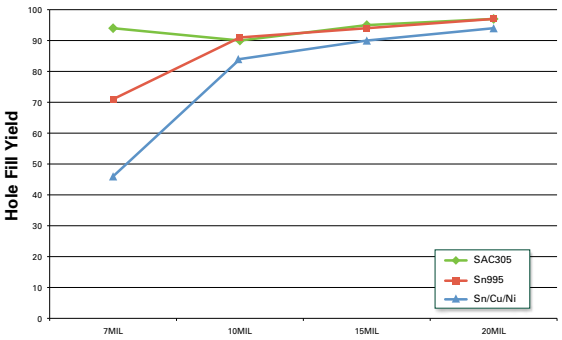
Bar Solder Elemental Specification and Impurity Limits (%)

Element	SAC305	Sn995	J-Std-006B	JIS Z 3282
Sn	96.3-96.7	99.3-99.7	n/a	n/a
Ag	2.8 - 3.2	0.0010	0.1000	0.0500
Cu	0.4 - 0.6	0.4 - 0.6	0.0800	0.0500
Pb	0.0500	0.0500	0.1000	0.0500
Al	0.0010	0.0010	0.0050	0.0010
As	0.0200	0.0035	0.0300	0.0300
Bi	0.0200	0.0100	0.1000	0.0500
Cd	0.0020	0.0010	0.0020	0.0020
Fe	0.0100	0.0050	0.0200	0.0200
In	0.0070	0.0100	0.1000	n/a
Ni	0.0020	0.0060	0.0100	n/a
Sb	0.0500	0.0250	0.0500	0.0500
Zn	0.0010	0.0010	0.0030	0.0010
Co	n/a	<0.1000	n/a	n/a
Au	0.0020	0.0002	0.0500	n/a

Hole Fill: VOC-Free Flux WF7742 and Pot Temperature 270°C



Hole Fill: No-Clean Flux WF9942 and Pot Temperature 270°C



Selective Soldering

As boards use fewer through-hole components and feature more temperature sensitive components at a finer pitch, selective soldering is becoming a popular alternative to wave soldering.

Benefits of selective soldering:

- Lower initial costs – smaller volume of solder per pot
- Localized heating of board reduces impact on adjacent components
- Precise application of solder wave optimizes hole fill
- Flux application only in necessary areas insures reliability

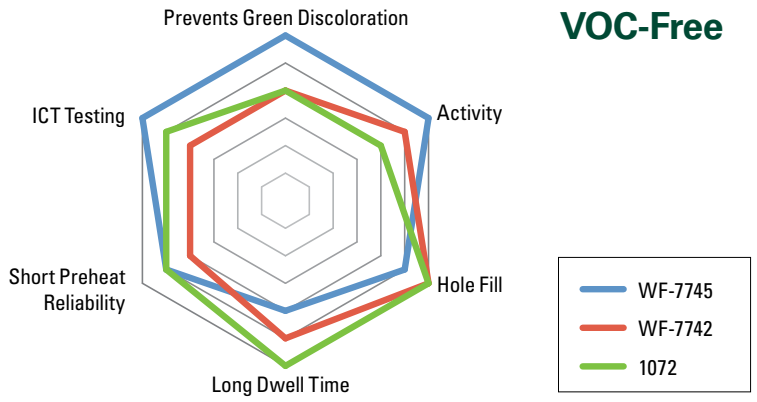
Indium provides solid wire in 5lb. spools for selective soldering. Commonly, Sn995 and SAC305 are used; however, alternate alloys are available

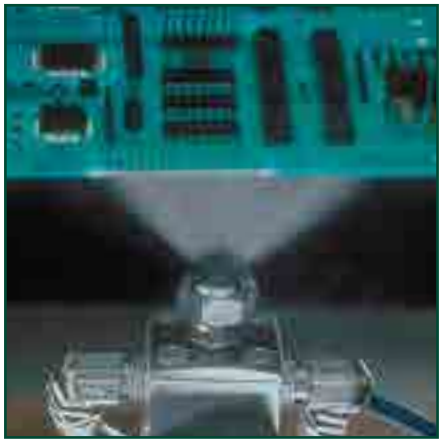
Wave Solder Fluxes

For more on wave solder fluxes
indium.us/D200

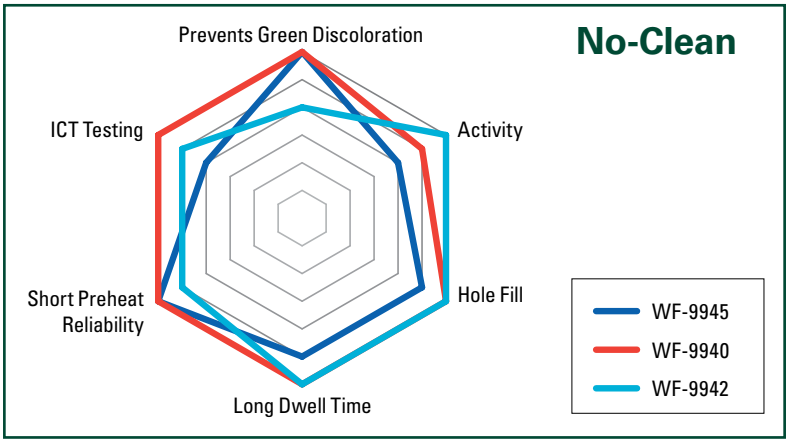
	No-Clean	Water-Soluble	VOC-Free	Halogen-Free	Halide-Free	Rosin-Containing	Solids Content	Acid Value (%)	Neutral pH	Foaming Application	Spray Application
WF-7745	●		●	●	●		4.22	39.30			●
WF-7742	●		●		●		5.76	36.00			●
1072	●		●			●	5.00	25.00			●
WF-9945	●			●	●	●	5.77	14.40		●	●
WF-9940	●					●	3.63	18.00		●	●
WF-9942	●				●		4.37	36.00		●	●
1095-NF		●					19.52	36.31	●		●
1081		●		●	●		28.44	60.82		●	
1010		●	●				20.96	79.17	●		●

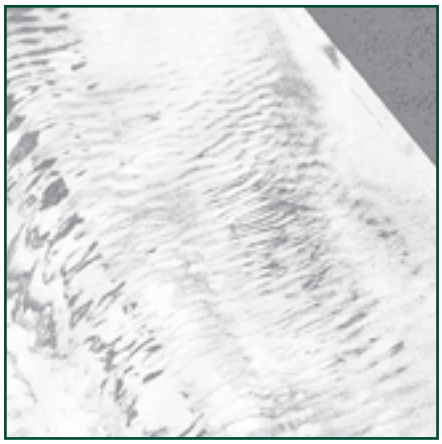
VOC-Free



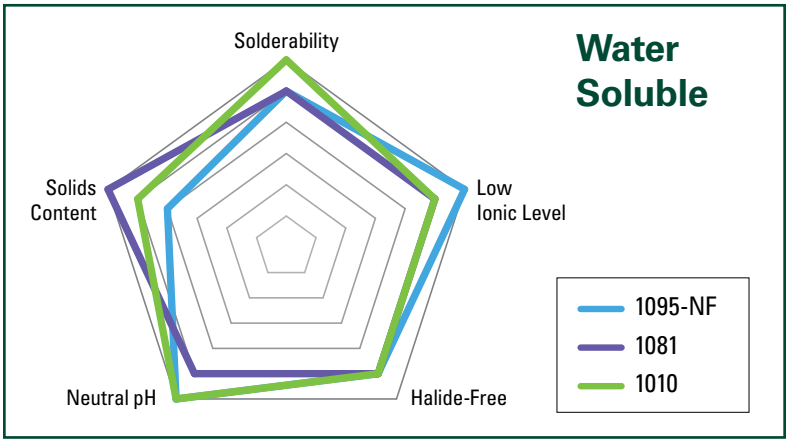


No-Clean





Water Soluble



Rework, Repair, and Touch-up Materials

For more about rework materials
indium.us/D300

Flux-Cored Wire

	Application	Recommended Flux %	Flux Classification	Halogen-Free (JEITA ET-7304)	Contains Rosin	Low Odor	Solders Oxidized Copper	Solders Nickel	Solders Brass
CW-807	No-clean	1.25	ROL1	Yes	Yes	Best	Best	Better	Good
CW-802	No-clean	1.25	ROL0	Yes	Yes	Best	Better	Good	Good
CW-501	No-clean	2.00	ROL1	No	No	Good	Better	Good	Good
CW-201	Solvent clean	2.00	ROM1	No	Yes	Better	Best	Best	Best
CW-301	Water-soluble	3.00	ORH1	No	No	Better	Best	Best	Better

Commonly Available Diameters & Packaging

Metric Units			English Units		
Diameter	**Spool Weight**	**SAC305 Length**	**Diameter**	**Spool Weight**	**SAC305 Length**
0.25mm ± 0.05	125g	368 m	**0.010" ± 0.002"**	1/4lb	1097ft
0.40mm ± 0.05	125g	164 m	**0.015" ± 0.002"**	1/4lb	487ft
0.50mm ± 0.05	500g	368 m	**0.020" ± 0.002"**	1lb	1097ft
0.60mm ± 0.05	500g	236 m	**0.025" ± 0.002"**	1lb	702ft
0.80mm ± 0.05	500g	144 m	**0.032" ± 0.002"**	1lb	428ft
1.00mm ± 0.05	500g	92 m	**0.040" ± 0.002"**	1lb	274ft
1.55mm ± 0.05	500g	38 m	**0.062" ± 0.002"**	1lb	114ft

Standard Flux Percentages	
2%	1.6 to 2.2%
3%	2.7 to 3.2%

Liquid Rework Fluxes

- Packaged in convenient flux pen dispensers
- Fluxes for optimal fluxing – no waste

No-Clean

- FP-500
- NC-771
- Passes SIR without heating

Water-Soluble

- FP-300

- Incompatibility
- Fumes
- Smoke
- Residue

Superior Wetting

TACFlux™ Products

	Typical Tackiness (g)	Typical Viscosity (kcps)	Max Temp (°C)	Reflow Residue (%)	Reliability J-Std-004	Halide-Containing	Features
No-Clean	**Can be Cleaned with Semi-Aqueous Solutions**						
007	190	570	310	47	Pass	Y	RMA
010	232	67	450	4	Pass	N	Ultra-low residue, good for use with underfill; inert atmosphere required at high temperatures
020	175	470	250	45	Pass	N	Flux residue ideal for in-circuit testing since it will not clog crown probes
020B	250	800	260	45	Pass	N	Halogen-free; passes SIR without reflow; suitable for use with Pb-free and Pb-containing alloys
055	215	16	200	45	Pass	N	Halogen-free; ideal for use with low temperature BiSn and BiSnAg alloys
089	146	17	260	35	Pass	Y	Formulated for use with SAC solders; residue is clear and good for in-circuit testing
089HF	120	10	260	35	Pass	N	Halogen-free; formulated for use with SAC solders
Water-Soluble	**Easily cleaned with DI water with spray pressure and elevated temperature**						
025	550	850	370	47	Pass	N	Compatible with a wide variety of alloys

Available in syringes, jars, and cartridges

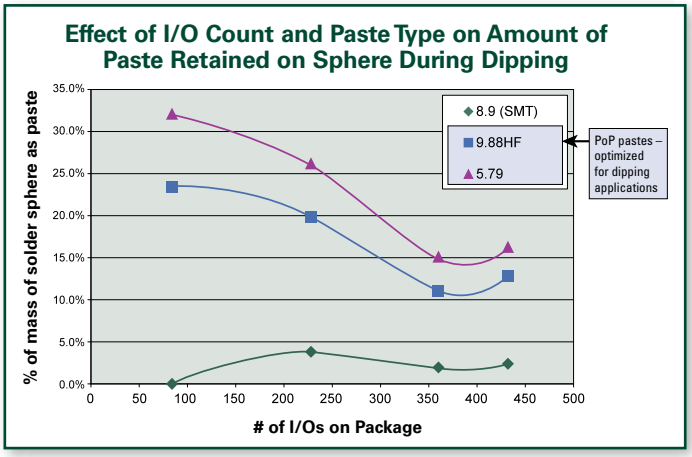
Advanced Technology

Package-on-Package (PoP) Assembly Materials

For more about PoP assembly materials
indium.us/E100

PoP Technology Basics

As devices shrink in size and expand in functionality, the capability to sequentially stack packages is becoming crucial. For instance, it is often useful to stack a PBGA memory chip on top of a logic package. Indium Corporation provides a variety of products to optimize your PoP process.



Material Requirements for Performance

- Appropriate for application by dipping
- Stable viscosity over time in dipping machinery with continuous smoothing
- Homogeneous – particle/crystal/bubble-free
- No cleaning of residue required
- Good wetting to a variety of pad metallizations and alloys
- Air reflow – stable for multiple reflows

PoP Products

FLUXES

Product Name	Application Method	Flux Designation	Halogen-Free*	Residue Level %	Typical Viscosity (kcps)	Typical Tack (g)
PoP Flux 030B	Dipping & Dispense	ROL0	●	~41%	130 (Brookfield)	140
PoP Flux 89HFLV	Dipping & Dispense	ROL0	●	~35%	8.5 (C&P - 5min)	170

PASTES

Product Name	Application Method	Flux Designation	Halogen-Free*	Residue Level (% of Paste)	Typical Viscosity (kcps)	Typical Tack (g)
PoP Paste Indium5.79 (for SAC305 only)	Dipping - BGA Repair	ROL1		~7%	270	90
PoP Paste Indium9.88HF	Dipping & Dispense	ROL0	●	~8%	250	65

All airlessly (bubble-free) packaged

**No intentionally added halogens*

PoP Paste vs. PoP Flux

Choose PoP Flux if:

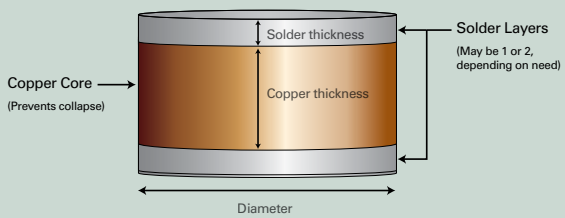
- Packages are small and rigid
- Warpage is not likely and thermal expansion is uniform for packages and substrate
- Solder contained in package solder balls is sufficient for strong joints

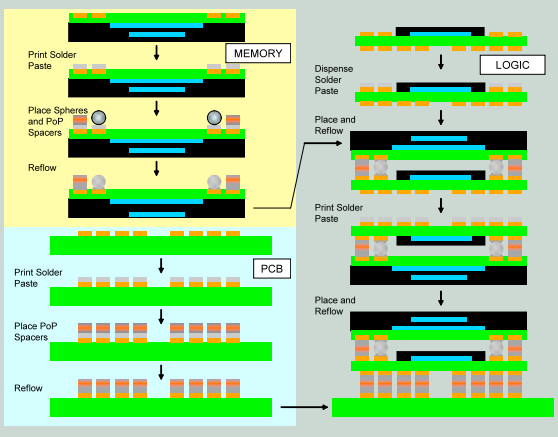
Choose PoP Paste if:

- Packages are prone to warping
- Printed PCBAs are being used as they are not typically as rigid
- "Crocodiling" is evident – top package is only reflowing to form joints along one side
- Head-in-pillow defects are a concern
- Additional solder will insure reliability of solder joints and provide assurance that connections will be made regardless of possible package warping

PoP Interconnect Spacers

- Solder coated copper preform
- Replace spheres
- Prevent collapse of solder joints
- Available in different dimensions
- Tin solder typical – other solder types available





Technical Support

Link to our technical support directory
indium.us/A100

From One Engineer to Another

Indium Corporation's research scientists, application engineers, and technical support engineers work closely with our customers to develop custom solutions to their technical problems and optimize their processes.

Indium Corporation's PhD scientists and engineers are certified by many of the top industry organizations, including the SMTA and the IPC. In addition, our Six Sigma Green Belt- and Black Belt-certified staff are trained in advanced process management methods to help you to:

- Increase yields
- Improve customer satisfaction
- Increase revenues
- Reduce defects
- Increase profits
- Deliver high value and return on investment

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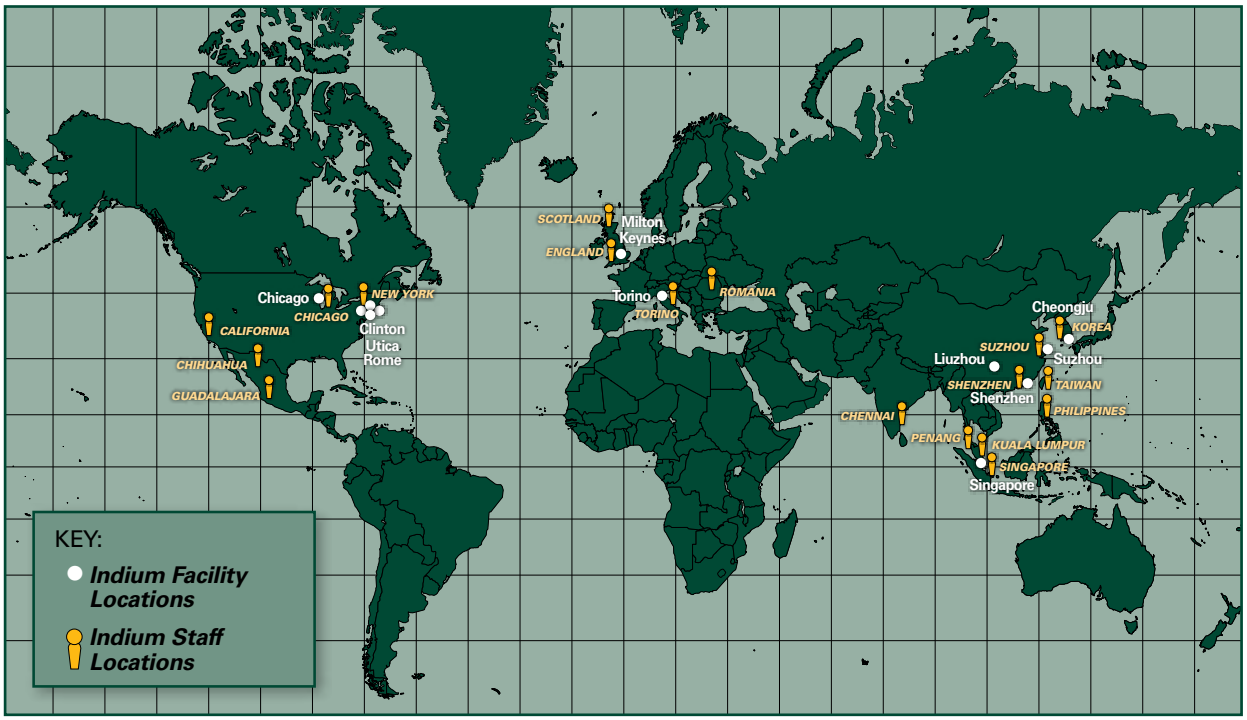
Also visit: knowledge.indium.com for our powerful, interactive, online technical knowledge base, available 24/7.



IEEE IPC SMTA Surface Mount Technology Association

iMAPS iNEMI 6σ semi

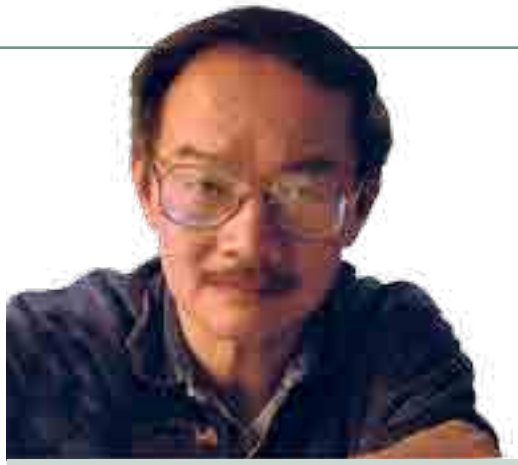
Research Labs

Indium Corporation performs research worldwide. We operate dedicated research laboratories in the USA and China.

Process simulation lab: provides the tools for our engineers to work with you on designed experiments to fully characterize materials and processes in leading-edge technology applications.

Thermal lab: analyzes the thermal resistance and conductivity of materials and applications to help optimize the best thermal interface materials for our customers' assembly processes.

Research and development labs: provide research scientists with the tools to advance material science for the creation of new and unique products for electronics, semiconductor, thermal management, and solar photovoltaics.



Indium's R&D team is headed by Dr. Ning-Cheng Lee, an SMTA Member of Distinction, author, and well-known expert in materials science and SMT assembly.

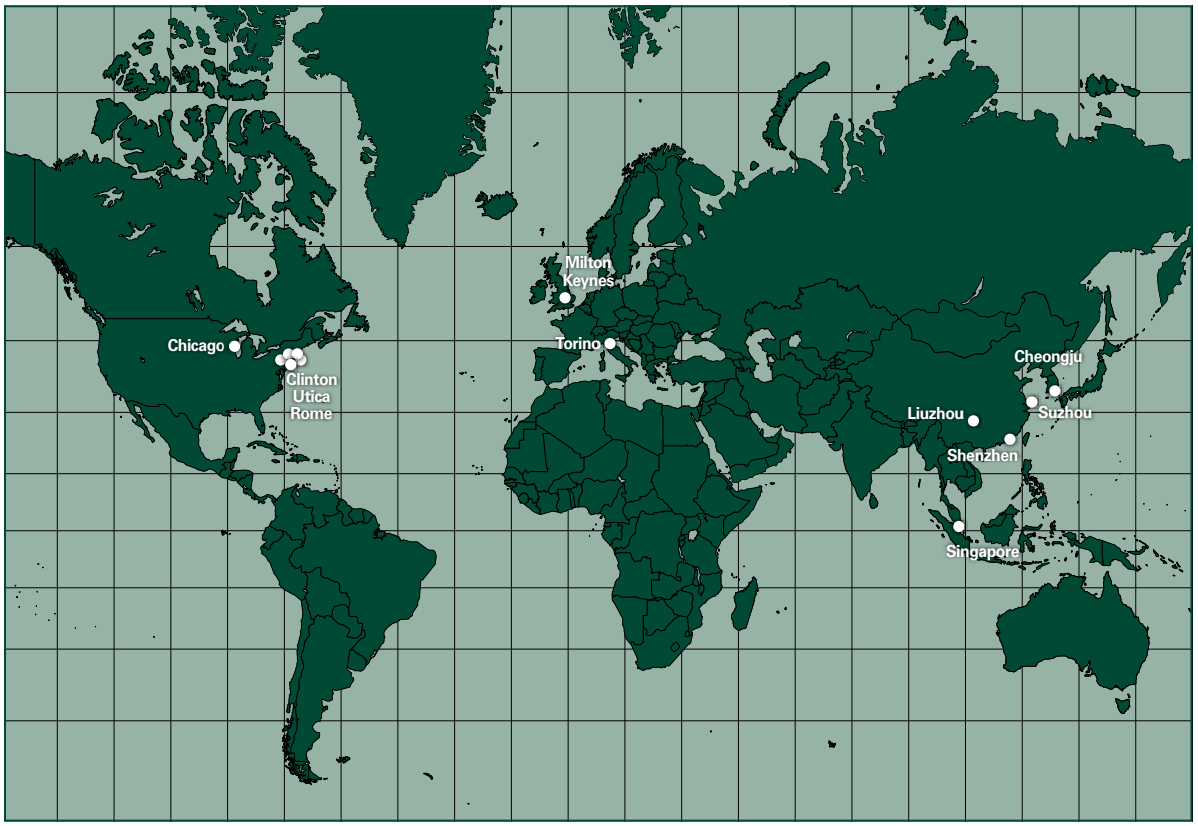
Our Goal

Increase our customers' productivity and profitability through premium design, application, and service using advanced materials.

Our basis for success:

- *Excellent product quality and performance*
- *Technical and customer service*
- *Cutting-edge material research and development*
- *Extensive product range*
- *Lowest cost of ownership*

- Electronics Assembly Materials
- Engineered Solders & Alloys
- Metals & Compounds
- Metal Thermal Interface Materials
- Nanotechnology
- Semiconductor Assembly Materials
- Solar Energy Materials



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