# Soldering to Gold

APPLICATION NOTE

The use of gold in electronics assembly is well documented. Gold is a noble metal, meaning it does not oxidize or tarnish to any appreciable extent. This makes gold ideal for a number of uses including plating contact surfaces for switches and connectors. Gold is the solderable surface either by itself or by preserving the finish on circuit boards and other assemblies.

Components and printed circuit boards are plated with gold ranging from a flash (5–15 microinches) to a heavy gold plate of several hundred microinches.

To form a quality joint when soldering to gold-plated components and boards, the wetting capability of the solder must be considered. For long-term reliability of a soldered assembly, a thermally-aged solder joint must not be brittle or susceptible to fatigue cracking.

Common tin-based solder alloys rapidly dissolve large quantities of gold during reflow. This can lead to complete and irreparable destruction of gold conduction patterns. The scavenging of a tin-based alloy can completely destroy a thick film gold layer in less than 30 seconds.

Scavenging also has a second—and more—insidious effect. The gold dissolved in the liquid solder precipitates as crack-inducing platelets within the solidified solder joint. For eutectic and near-eutectic tin-lead solders, the maximum permissible amount of gold is roughly 3% by weight. Above this threshold, brittle SnAu intermetallic compounds (IMC) form during cooling and while in service. There is little danger of this concentration being reached when soldering conventional electroless nickel immersion gold (ENIG)-coated printed circuit boards. With heavy gold thicknesses greater than 0.5 microns, the risk of embrittlement is considered significant, particularly in smaller joints containing less solder volume.

Indium-lead solders are known to cause appreciably less scavenging damage than tin-lead solders and are satisfactory for use on gold films thicker than 1 micron. Gold is essentially insoluble in indium. During soldering, indium forms the IMC at the solder interface and it remains in place. This lower solubility for gold results in much slower dissolution rates in indium alloys. In fact, tests have shown the solubility ratio of eutectic tin-lead solder compared to 50In/50Pb solder is 13-to-1 at 250°C. With the good wettability of InPb alloys and the same processing temperatures, InPb is a good drop-in replacement for SnPb to solve gold scavenging issues.

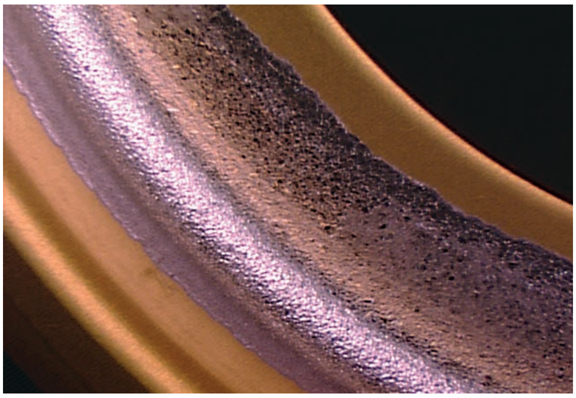

Image courtesy of SST International

## Alloy Choice

When considering alloy choice, both the operating temperature of the device and the maximum process temperature need to be taken into account. A good rule of thumb is to choose a solder with the solidus no less than 50°C above the maximum device operational temperature. An optimum process temperature will typically be 30°C to 50°C above the liquidus temperature of the solder.

The indium-lead alloy system contains a range of useful solder alloys from pure indium to pure lead. Alloys containing an excess of 80% lead can be used but have diminished wettability. Indium and lead form a nearly continuous solid solution.

The most commonly used alloy is 50In/50Pb, which has a liquidus of about 210°C and a solidus of about 185°C. Alloys in the lead-rich phase field freeze dendritically by forming lead-rich stalks. The formation of these dendrites causes a dimpling which gives the solder surface a somewhat frosty, rather than a shiny, appearance.

OVER→

Form No. 97743 (A4) R4

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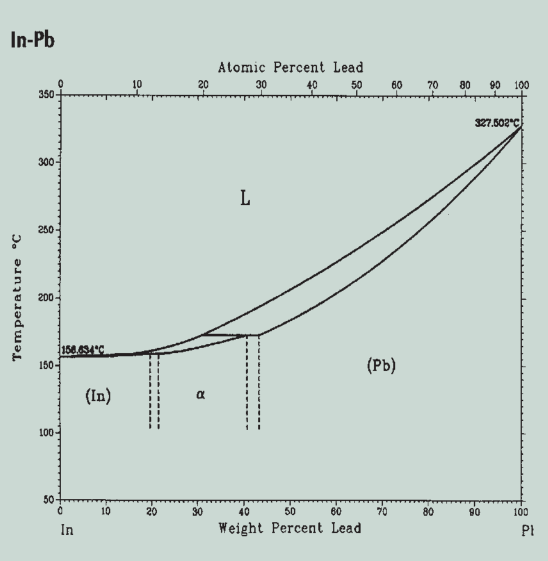
| Indalloy Number | Melting Temperature (Liquidus / Solidus) | Composition |
|---|---|---|
| # 290 | 143°C E | 97In 3Ag |
| # 2 | 154°C / 149°C | 80In 15Pb 5Ag |
| # 4 | 157°C MP | 100In |
| # 204 | 175°C / 165°C | 70In 30Pb |
| # 205 | 181°C / 173°C | 60In 40Pb |
| # 7 | 210°C / 184°C | 50In 50Pb |
| # 206 | 231°C / 197°C | 60Pb 40In |
| # 3 | 237°C / 143°C | 90In 10Ag |
| # 10 | 260°C / 240°C | 75Pb 25In |
| # 150 | 275°C / 260°C | 81Pb 19In |
| # 12 | 310°C / 290°C | 90Pb 5In 5Ag |
| # 164 | 310°C / 300°C | 92.5Pb 5In 2.5Ag |
| # 11 | 313°C / 300°C | 95Pb 5In |




## Flux Choice

It is possible to solder to gold without flux under certain circumstances. However, if the plated layer is thin and possibly porous, then the gold can become totally assimilated into the solder. In this situation, flux choice is then determined by the characteristics for the underlying metal.

For reflow temperatures in excess of 330°C to 350°C, forming gas is effective and may be used instead of flux. An inert atmosphere will increase flux efficiency and simplify cleaning issues in high-temperature applications where a flux is still required. For fluxless soldering with high-indium alloys, an inert atmosphere is required.

## Precautions

Even though indium-containing solders solve numerous critical joining applications, certain precautions must be taken concerning metal compatibility and corrosion:

- If the operational temperature of the device exceeds 125°C, solid-state diffusion of the gold may occur, resulting in the growth of the AuIn IMC layer. In such cases, 80Au/20Sn or a high- lead alloy can be used instead, according to process or commercial restraints.
- Indium can be corroded by halides. Indium-based joints should be protected in service from halide- containing materials or if humidity will exceed 85% in the presence of halides (a marine environment, for example). This can be accomplished with the use of a conformal coating.
- Fluxes based on halide activators (and any cleaners containing chlorinated hydrocarbons) should be avoided when using indium-based alloys. Using such fluxes can cause corrosion of the solder joint at a higher rate than for a tin-lead joint.

## Summary

Using an indium-lead solder can increase the reliability of solder joints made on gold-plated surfaces. Our Soldering to Gold Research Solder Kit can help you find the right solder alloy for your application.

APPLICATION NOTE



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