PACKAGING MATERIALS TECHNICAL BULLETIN

Pb-Free Die Attach

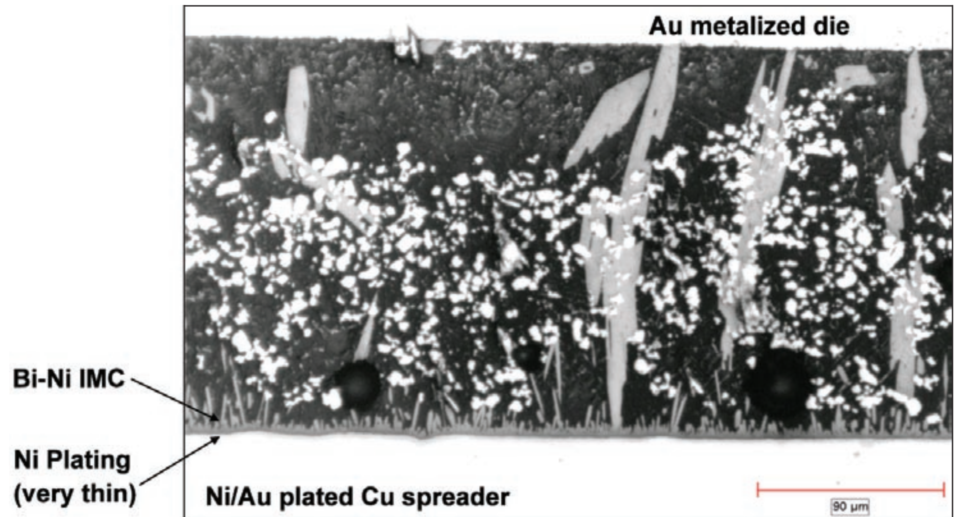
High Temperature Pb-Free Solders

Honeywell Electronic Materials Alloy 31 & 37 Solders are Pb-free solders for applications including power MOSFETs, IGBTs, multichip modules and RF Power transistors. These solders are designed to replace the high-Pb solders that are currently used where a solidus temperature of more than 255°C is required along with process temperatures of 400°C or less. Alloy 31 & 37 solders exhibit excellent reliability in thermal cycling. They wet Ag and Au very well, Ni fairly well, and do not wet/bond to Cu. The thermal conductivity is less than high-Pb alloys but is far higher than polymeric materials that can be used for the same applications. Alloy 31 and 37 solders are available as wire with a diameter of 0.51 to 0.76 mm (0.020" - 0.030").

BENEFITS

Developed as a replacement for high-Pb die attach solder wire:

- **Bi based alloy system**
  - Two alloys available with slightly different properties
  - Bulk thermal conductivity >19 W/m-K
- **Meets RoHS requirements**
  - <100ppm Pb
- **Designed not to melt during board level reflow**
  - Melting point above 255˚C
- **Meets reliability requirements**
  - 500 hrs @ 150˚C
  - 500 JEDEC condition B (-55/+125˚C) thermal cycles
- **Wire for use in solder die attach equipment**
  - Both 0.51 and 0.76mm (0.020" and 0.030") diameter



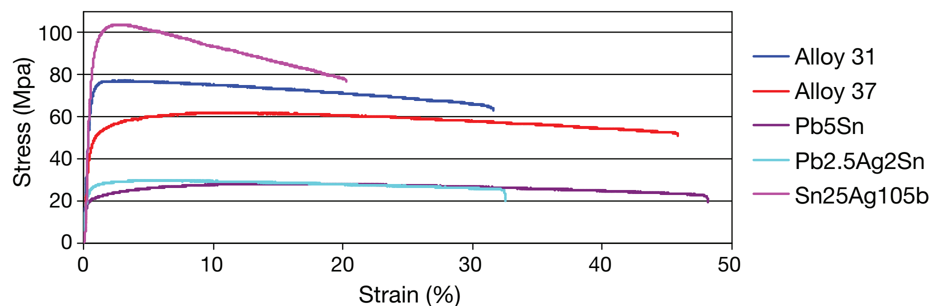
Solid Joint After 500 hours @ 150˚C

PHYSICAL PROPERTIES COMPARISON

The properties of the new Pb-free alloys are summarized in the table below.

The mechanical properties are intermediate between the common high-Pb alloys and alloy J.

Alloy	Density (g/cm³)	Thermal Conductivity (W/m-K)	Tensile Strength (MPa)	Young's Modulus (GPa)	Strain at Failure (%)
31	9.63	19.8	77.6	14	14
37	9.74	19.6	62.0	12	12
Pb5Sn	11.04	31.5	29.8	5.3	5.3
Pb2.5Ag2Sn	11.04	31.3	28.3	5.9	5.9
Sn25Ag105b	7.91	24.8	103.5	16	16



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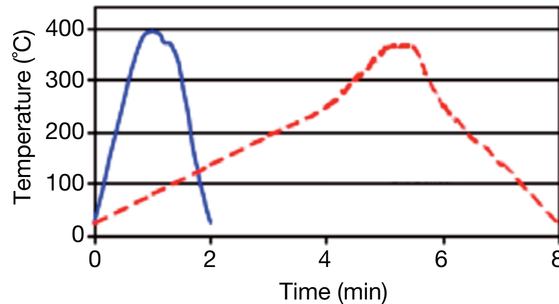
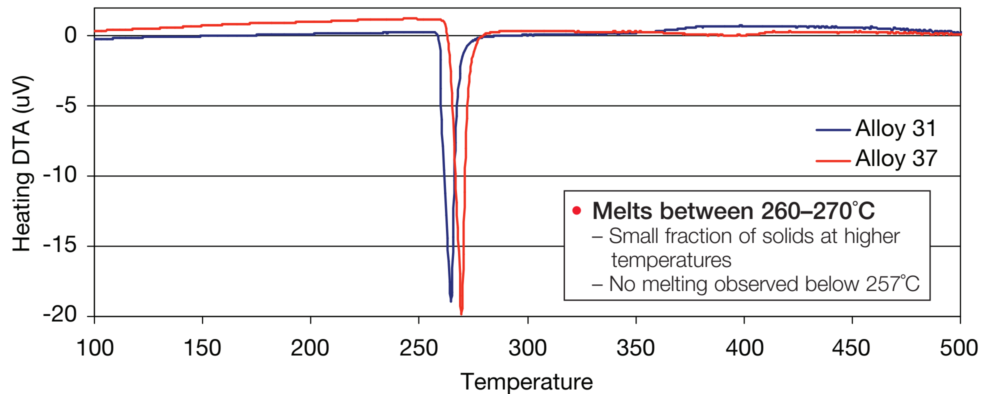
PROCESS CONDITIONS

The majority of the melting for Alloy 31 and 37 occurs at 260-270°C as shown in DTA plot below with a small fraction of solids present at higher temperatures. The attached profile giving the temperature of the solder joint as a function of time should work quite well. It is designed to get the substrate hot enough for a long enough time so the H_2 in the forming gas removes the oxides from the Ni plating without causing too much reaction between the solder and the metalization. The lead frame temperature in the die bonder should be raised above 360°C to remove any oxides.



The solder should be processed in an inert or a reducing atmosphere. An inert atmosphere (N_2 or Ar with less than 10ppm O_2) will work for many belt furnace applications. However, a reducing atmosphere (5–10% H_2 in N_2 or Ar) works better since the H_2 reduces the oxides on the substrate and the solder at the soldering temperatures of 340–400°C.



Designed not to melt during board level reflow

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