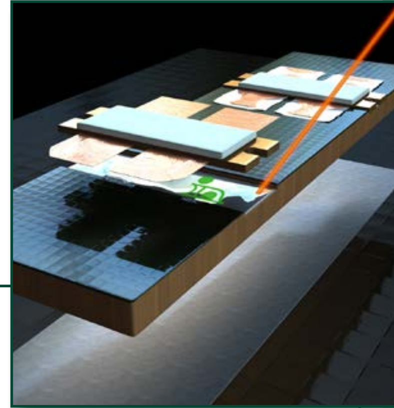
NanoBond®: The Process for Using NanoFoil®

NanoBond® is the process of bonding two components with solder using **NanoFoil®** as a heat source. When activated, the foil creates a self-sustaining reaction that acts as a rapid and controllable localized heat source to melt adjoining solder layers, bonding components together. Processing details vary with components, but some basic bonding details are:

- NanoFoil selection and sizing
- The 3 Ps - plating, planarity, and pressure
- NanoFoil activation



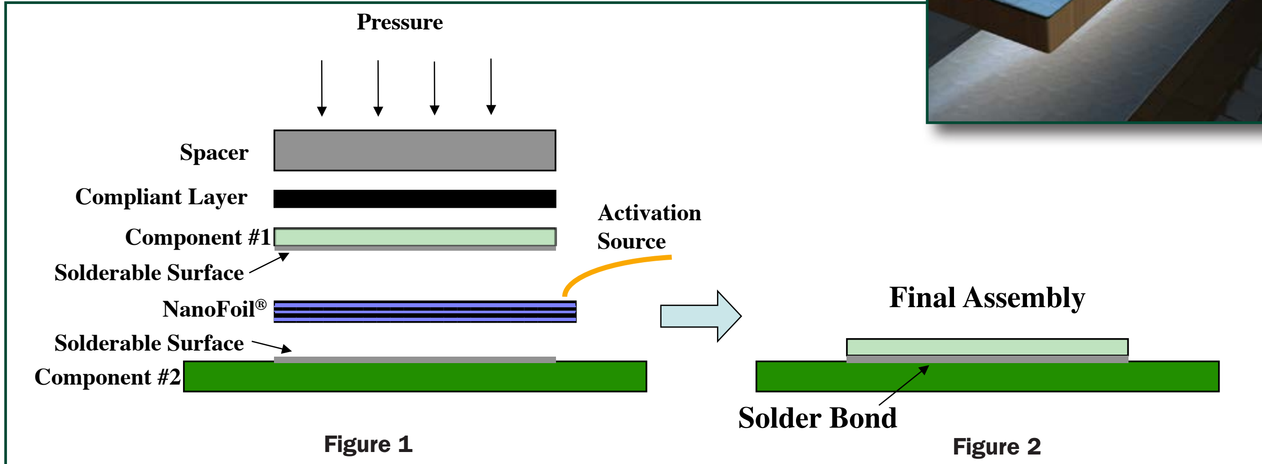


Figure 1

Figure 2

NanoFoil Selection and Sizing

NanoFoil is available as:

- **Standard NanoFoil** - a localized heat source that, when combined with solder performs or a solder-coated surface (<450ºC), can be used to join two materials together.
- **Tin-Plated NanoFoil** - standard NanoFoil coated with 10µm of pure tin on both sides. Tin-plated NanoFoil only requires solderable surfaces to create a bond.

The NanoFoil should match the size and shape of the bondline, with the exception of exposed foil for activation if necessary (see the section on **NanoFoil Activation**). The foil should be oversized 1mm for any holes, or undersized 1mm for any edges that need to be clear of solder to prevent overspray of solder and foil material. Thicker NanoFoil can be used to join materials in the brazing range of 450°-700°C.

NanoFoil Availability and Properties*

Property	Value
Standard Thicknesses (µm)	40, 60, 80
Tin Plated Thickness (µm)	40, 60, 80
Minimum Available Size	1mm x 1mm
Composition After Reaction	$Ni_{50}Al_{50}$
Heat of Reaction	1050-1250 J/g
Maximum Reaction Temp	1350-1500°C
Thermal Conductivity	35-50 W/mK

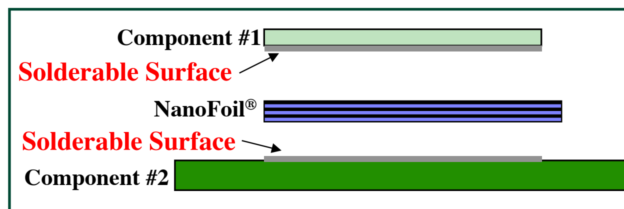
**Please contact Indium Corporation for safety and handling*

The 3 Ps: Plating, Planarity, and Pressure

Plating: Two Solderable Surfaces

A solderable surface is a surface to which solder will flow and wet to without the help of flux. a solderable surface is necessary for both standard and tin-plated NanoFoil. Some recommended solderable finishes are:

- ENIG <1micron
- Gold- or silver-plating: 1-15µm
- Solder-plating: 10-15µm
- Hot plate soldering: 10-250µm



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Form No. 98626 R0

www.indium.com askus@indium.com

ASIA: Singapore, Cheongju, Malaysia: +65 6268 8678
CHINA: Suzhou, Shenzhen: +86 (0)512 628 34900
EUROPE: Milton Keynes, Torino: +44 (0) 1908 580400
USA: Utica, Clinton, Chicago, Rome: +1 315 853 4900

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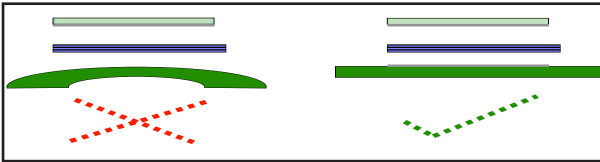
This table matches the component surface finishes with the recommended NanoFoil types. NanoFoil thickness is determined based on solder and component type, composition, and sensitivity.

Recommended NanoFoil	Component 1 Plating	Component 2 Plating
Tin-plated	ENIG, Au, Ag	ENIG, Au, Ag
Tin-plated	ENIG, Au, Ag	Solder-plated
Standard using solder preforms*	ENIG, Au, Ag	ENIG, Au, Ag
Standard	Solder-plated	Solder-plated

** Solder preforms can be used with NanoFoil and appropriate surfaces*

Planarity: Two Flat Surfaces
Another key component for a successful NanoBond is the planarity of the components relative to one another and to the NanoFoil. NanoFoil can accommodate bowing up to 0.1% of the overall length in one or both of the components. Since the NanoFoil reaction occurs in less than 5 milliseconds, flatter bonding surfaces will ensure better contact with the foil and prevent voiding or uneven bonding. In addition, flatter components will require less applied pressure to create a good bond (see below).



Pressure and Alignment
The pressure application requires three components: adequate pressure, uniform pressure, and constant pressure.

- Adequate Pressure: A spacer should be used to step the pressure to the size of parts being joined; actual pressure depends on planarity and part sensitivity. (i.e., a solid metal component may need 50psi, but a sensitive die may only be able to withstand 0.5 psi)
- Uniform Pressure: A compliant layer, such as foam, should be used to spread the load. We recommend 2# EVA Foam from Rubberlite.
- Constant Pressure: Since solder will be molten for a few milliseconds during activation, constant feedback pressure from a **hydraulic**, **air-driven** or **mechanical-driven** (spring) press or fixture is required.

Alignment is also an important part of the activation process as parts can shift if they are not properly aligned. (See Figure 1 on the front page)

NanoFoil Activation

NanoFoil can be activated with a small pulse of local energy applied by using optical, electrical, or thermal sources. Applying energy at a local point is just as important as the amount of energy applied.

- Thermal: soldering iron or 250°C temperature
- Electrical: resistance soldering iron or a battery (50 watts of power)
- Optical: laser

NanoFoil must be in direct contact with the energy source when activated. In most cases, this requires oversizing the foil or cutting a tab in the foil. However, once activated, foil outside of the bond will leave a brittle metallic alloy that may need to be cleaned. Sizing the NanoFoil to the exact bondline and activating it with a laser or fine wire will eliminate this post reaction material.

Application Highlight

Power Amplifier Packages can be bonded with the NanoBond process. Using existing ENIG-coated packages with flanges for attach allow for the use of tin-plated NanoFoil without oversizing, with access to the foil through the flange. Following are bonding details:

- Solderable surfaces:
  - Power amp – ENIG
  - Heat-sink – gold
- NanoFoil: 40µm tin-plated
- Sizing: footprint of bond including flanges
- Planarity: parts measured .05% of total length
- Pressure
  - 500lb hand spring press
  - ¼″-thick foam
  - 50 psi
- Activation
  - American Beauty resistance soldering iron

APPLICATION NOTE

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www.indium.com askus@indium.com

ASIA: Singapore, Cheongju, Malaysia: +65 6268 8678
CHINA: Suzhou, Shenzhen: +86 (0)512 628 34900
EUROPE: Milton Keynes, Torino: +44 (0) 1908 580400
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