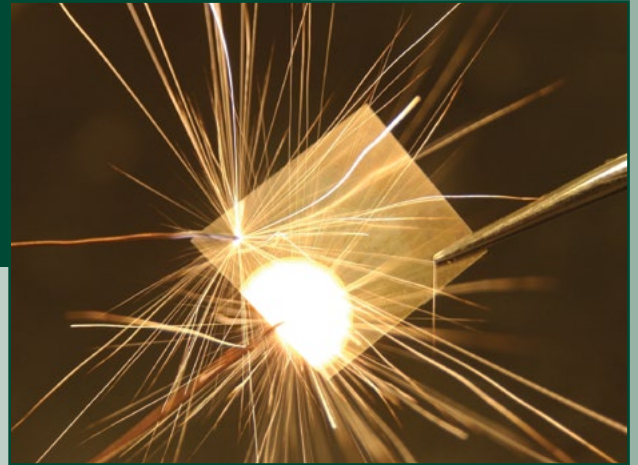


NanoFoil[®] User Guide

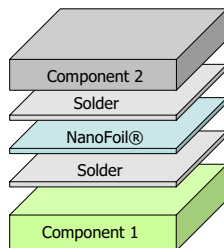
NanoFoil[®] consists of thousands of nanoscale layers of aluminum and nickel which react exothermally when initiated with an energy pulse. The foil creates a self-sustaining reaction that acts as a rapid and controllable localized heat source to melt adjoining solder layers, bonding components together. This process is called the NanoBond[®].



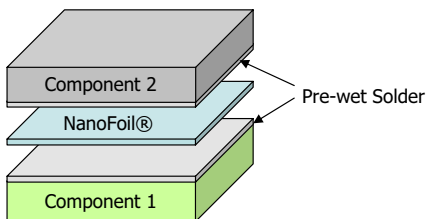
NanoBond[®] Process

Step 1: Configuring the bond interface structure
NanoFoil[®] is placed between two components that need to be bonded, along with two layers of solder.

a. **Freestanding solder preforms or solder-plated foil components** are used when components are Au-metallized, easy to wet, or have low thermal conductivity.



b. **Solder pre-wet onto the components** is used when the components are difficult to wet or have high thermal conductivity.

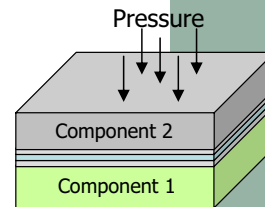


Step 2: Prepare the surfaces

Component surfaces should be flat (machined or conditioned), smooth, and clean. In configurations where the components are not pre-wet with solder, it is necessary to remove the surface oxide through plating or etching. A 10% HCl solution is usually sufficient to remove oxides from components and solder.

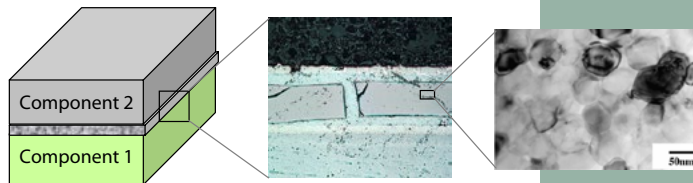
Step 3: Alignment and pressure

To ensure proper wetting of the component surfaces, it is important to properly align the solder, NanoFoil, and components. Apply the proper amount of pressure to the components to allow the molten solder to flow and properly wet the component surfaces. For instance, when using components pre-wet with indium solder, use 50 psi. A spring is recommended to apply a constant pressure throughout the joining process.



Step 4: Activate the NanoFoil

The NanoFoil is designed to chemically react and give off heat to melt the solder. The NanoFoil can be activated with a small pulse of local energy, which can be applied using optical, electrical, or thermal sources.



From One Engineer
To Another[®]

NanoFoil® User Guide

Suggested Equipment

Below is a list of equipment that can be used to create a NanoBond®. Equivalent equipment can be substituted, such as using a laser instead of an electrical ignition source.

Equipment

- Imada DPS-110R Digital Push/Pull Force Gauge
- Imada HV-110 Vertical Wheel Stand
- Assembly Technologies Model 105A3 American Beauty® 100W Power Unit
- Assembly Technologies Model 10552 American Beauty® 5/64" Diameter Single Stainless Steel Handpiece
- Assembly Technologies Model 10519 Foot Switch
- Plastic tweezers with no sharp points
- Spring plunger (available from McMaster-Carr)



Imada Digital Push/Pull Force Gauge



Imada Vertical Wheel Stand



Power supply for ignition with single probe hand piece.

NanoFoil® Cutting Procedure

Personal Protective Equipment

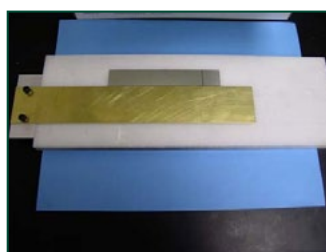
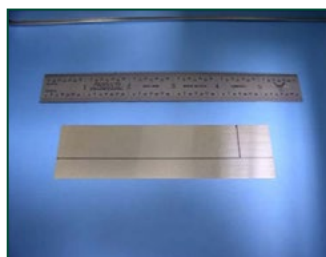
- Safety glasses
- Leather gloves

Additional Supplies Needed

- Glass cutter with carbide wheel
- T-square

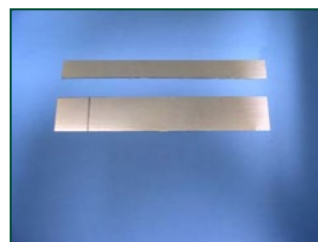
Procedure

1. Measure and draw the lines for the desired geometry on the NanoFoil. Add a slight margin to compensate for the cutting loss. It is also advisable to make the larger cuts along the striations of the foil, as it is easier to cut along the striations than against them.
2. Place NanoFoil on a flat surface, preferably a plastic cutting board.



Place the T-square on top of the NanoFoil along one of the drawn lines.

3. Place the carbide wheel on top of the drawn line.
4. With one hand, press down on the T-square to hold the NanoFoil in place.
5. With the other hand, roll the glass cutter back and forth while pressing down firmly to cut along the drawn line. It may take more than one pass until the NanoFoil is cut completely.
6. Repeat steps 4 and 5 until the NanoFoil is completely cut to desired geometry.
7. Pen markings can be wiped off using methanol.



Ignition Suggestions

Electrical Ignition

- To ignite the foil with a momentary point contact from an electrical probe, 10A and 5V is sufficient.
- To ignite the foil using ohmic heating, the current must be 100-120A for a 15µm contact diameter and 250-300A for a 300µm contact diameter.

Laser Ignition

Below is a table of conditions for various laser types that will consistently ignite the NanoFoil.

Laser Type	Pulse Duration (sec)	Spot Diameter (µm)	Pulse Power (mJ)
YAG laser: wavelength 1064 nm, pulsed	8 x 10 ⁻⁹	100	>300
YAG laser: wavelength 1064 nm, pulsed	8 x 10 ⁻⁹	50	>50
YAG laser: wavelength 1064 nm, pulsed	8 x 10 ⁻⁹	10	>10
CO2 laser: 200W, wavelength 10600 nm, continuous	3 X 10 ⁻⁴	100	—
IPG: 100W, wavelength 1085 nm, continuous	1 x 10 ⁻⁴	50	—
IPG: 50W, wavelength 1085 nm, continuous	5 x 10 ⁻⁴	100	—

- NanoFoil can be ignited with many other concentrated energy sources, such as a hot filament or flame.
- NanoFoil will ignite when heated to 200°C at a heating rate of 200°C/min using any heating method.

Note: If heated too slowly, the NanoFoil will anneal, losing its ability to create a self-sustaining reaction.

Storage and Handling Guidelines

General Safety Requirements

- Never handle NanoFoil with bare hands. Always use non-pointed tweezers or heat-resistant gloves.
- When working with NanoFoil, wear safety glasses at all times.
- Do not use in the vicinity of solvents or flammable items.
- Keep unreacted NanoFoil covered and away from the joining area.
- Do not store NanoFoil in the joining area.
- All unused NanoFoil must be placed in a fire-retardant bin for proper disposal.
- When bonding with NanoFoil, wear cotton gloves and long sleeve shirts to prevent burns caused by solder spray.

Handling Recommendations

- NanoFoil can be applied manually using tweezers.
- NanoFoil can also be handled by pick and place equipment.
- Always transport NanoFoil in its container; the impact from falling may activate the foil.

In Case of Fire

NanoFoil will react completely and virtually instantaneously, generating large quantities of heat, but no flame. The primary fire hazard is the ignition of surrounding flammables. If any of the foil is in the midst of other burning materials, use the appropriate extinguishing agents for those materials.

Storage

Shelf life is 12 months after date of shipment when stored in its original unopened container in a cool, dry environment between 60°F and 75°F (15.5°-23.5°C). The location must be approved for flammable materials.

Shipping

NanoFoil® is regulated by the Department of Transportation as a hazardous material (flammable solid) and subject to the regulations in 49 CFR. Do not ship without proper training.

NanoFoil® Activation Kit

Equipment Provided

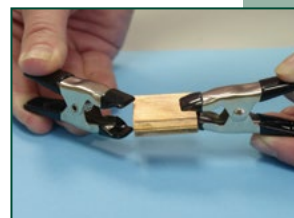
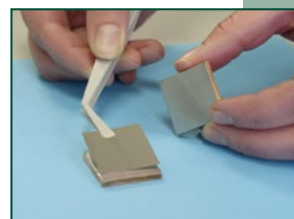
- 9V battery with ignition probe
- Demo instructions
- Metal tweezers
- Cutting procedures
- Steel wheel glass cutter
- MSDS
- 2 sets of tin-plated copper blocks
- NanoFoil User Guide
- Clamps
- Demo ignition video CD
- 10 pieces of 1.0" x 1.0" pieces of NF40 (40 micron NanoFoil)

Safety and Handling

- Always use tweezers or heat resistant gloves while handling NanoFoil.
- Wear safety glasses when working with NanoFoil.
- Do not use NanoFoil in the vicinity of solvents or flammable items.
- All unused NanoFoil must be ignited before disposal.

User Guide

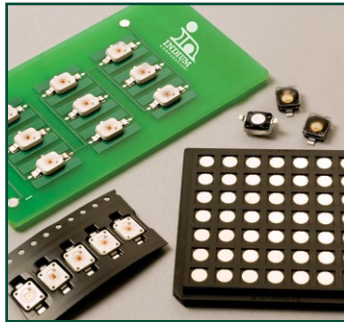
1. Remove a piece of NanoFoil from the package and place it between the two soldered-coated copper blocks. Place the NanoFoil so that there is access to the NanoFoil outside of the copper blocks for ignition. Be careful not to drop the copper blocks on the foil, as this can initiate a reaction.
2. Place the two clamps on opposite sides of the copper blocks. This pressure will allow for solder flow and provide a strong bond.
3. Set the clamped copper blocks down, since there may be some solder spray (the bottom of the demo box will work well). Hold the igniter by the 9V battery and touch the two leads to the NanoFoil. Any unused NanoFoil should be ignited on a non-flammable surface and placed in a disposal bin when cool.



The MSDS for this product can be found online at <http://www.indium.com/techlibrary/msds.php>



Technical and Sales Support



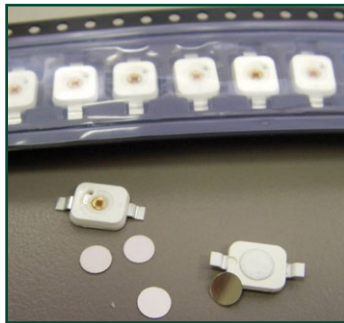
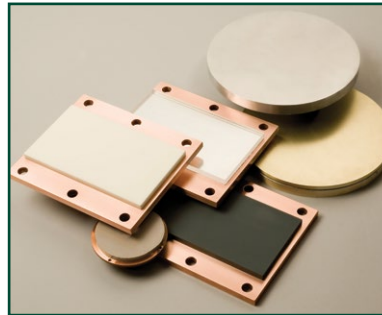
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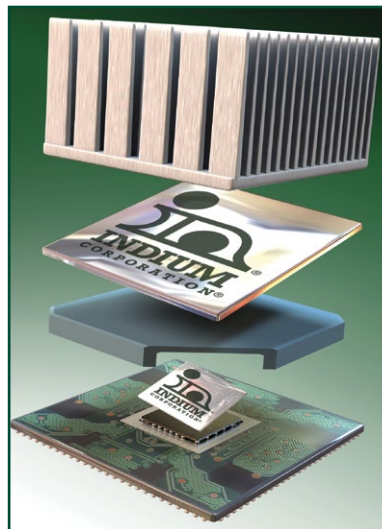
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