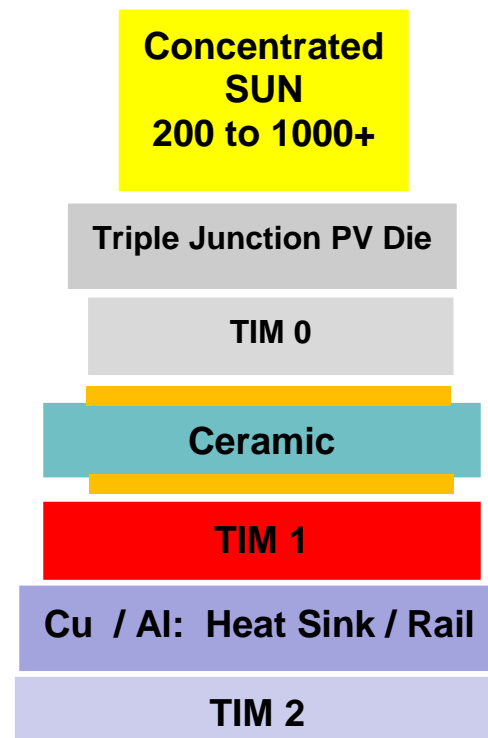


CPV APPLICATION NOTE

Using NanoFoil® to replace traditional adhesives for TIM1 interface for Concentrator Photovoltaics (CPV)

APPLICATION DESCRIPTION

NanoBond®, a joining process using NanoFoil®, can be used to replace traditional adhesives for improved thermal management at the TIM1 interface (shown here in red) in CPV receiver applications. This is accomplished by joining thick, stress-absorbing solder layers together using NanoFoil®. The use of solder material as a replacement for traditional adhesives to bond the dissimilar materials of ceramic substrate to metal heat sinks improves thermal conductivity, provides lower junction temperatures (Tj max) resulting in improved efficiency and longer lifetime of products. As an additional benefit, NanoBond® eliminates the need for conventional reflow limiting thermal exposure of other components in the assembly.



NANOBOND® ADVANTAGES

Features	Benefits
6-10x Lower Thermal Resistance than Adhesives	Lower Tj Max Increased conversion efficiency Longer lifetime
Flux-free, Metallic Bond	High strength, low thermal resistance, low electrical resistance No corrosion from flux residue Minimizes voiding
Uniform Bond Line Thickness	Consistent performance characteristics Consistent package height Improved package mounting planarity
Limited Thermal Exposure	No curing or reflow ovens necessary Components not exposed to reflow temperatures
Ease of Bonding	Lead-free, RoHS compliant Suitable for automated assembly

MATERIAL DESCRIPTION

NanoFoil® is a self-contained, localized heat source. The foil is a RoHS compliant material consisting of hundreds of alternating nanoscale layers of Aluminum and Nickel. Once activated, inter-mixing between the alternating metal layers generates heat within the foil. This heat can be used to melt adjacent solder layers and join components together with minimal thermal exposure of the components.

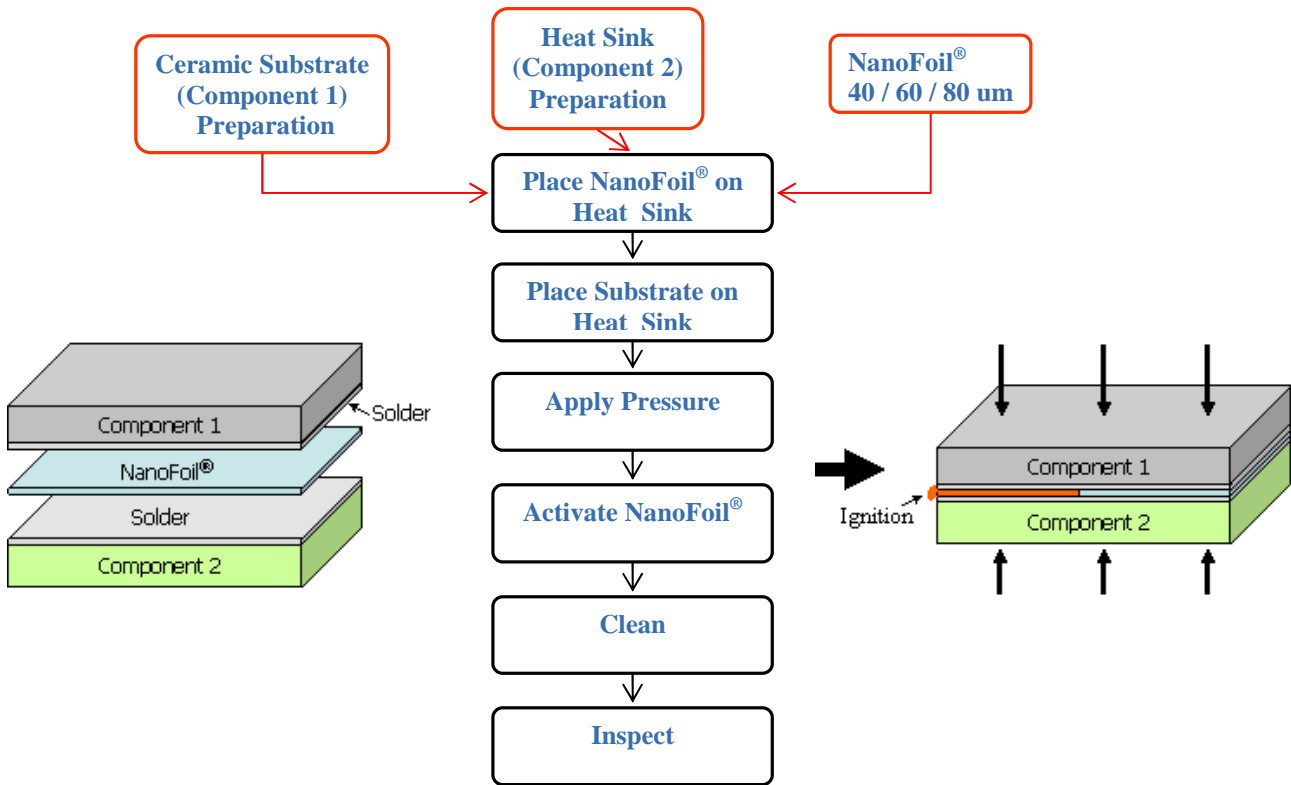
TYPICAL NANOBOND® PROPERTIES

Physical Property	Typical Value
Thermal Conductivity	25 W/mK
Bond Line Thickness	350 µm
Void Content	< 5%

Additional NanoFoil® properties can be found in NanoFoil® Datasheet

THE NANOBOND® PROCESS

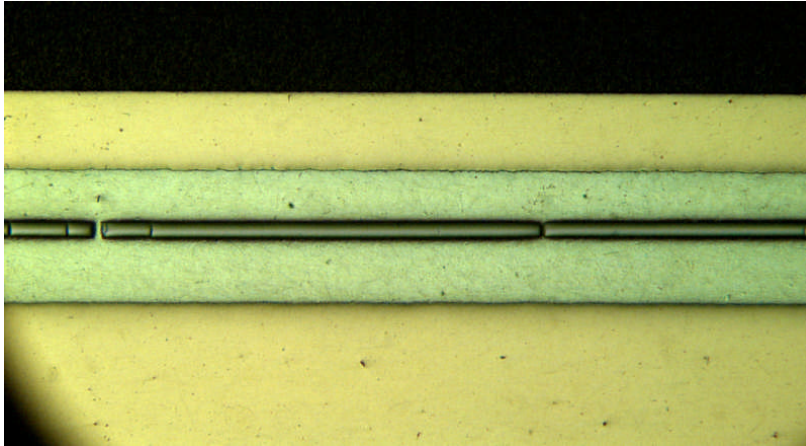
The key process requirements and steps to achieve TIM1 NanoBond® are shown below. Critical elements in the process flow include the ceramic substrate and heatsink preparation where a specified thickness of solder layer is added. The correct thickness of solder layer in combination with the correct thickness of NanoFoil® to be added depends on the application. For details regarding application specifics, please contact RNT.



RELIABILITY TESTING

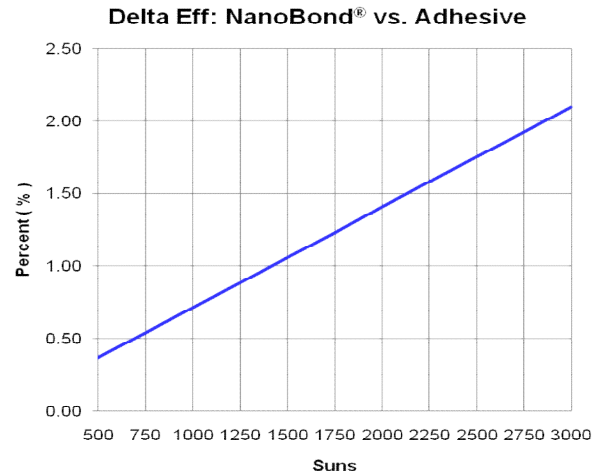
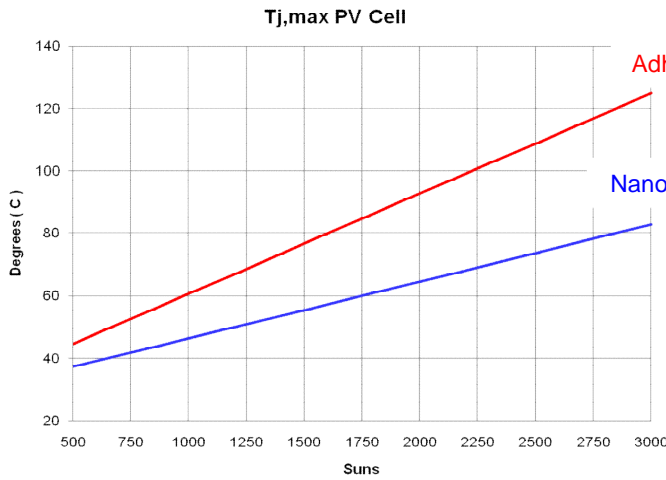
Test	Conditions	Result (Bond Quality)
Temperature Cycling	-25°C to +125°C, $t_{\text{extreme}} = 15 \text{ min}$, 500 cycles (8.5C per minute ramp)	Passed

Cross-section, NanoBond[®] solder solution after 500 cycles



PERFORMANCE

CPV Cell Performance - NanoBond[®] vs. Adhesive



Delta T_{j,max} - Increase vs. Suns

- Lower T_{j,max} - Increase Lifetime
- Or More Sun Headroom

Effect of T_{j,max} on Efficiency

- 0.5% / 10 C
- Increased Pout (dc)

DNI 850 W/m2
 Efficiency 35%
 Base Plate Held 28C