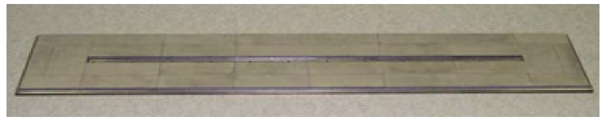
Bonding Sputter Targets with NanoFoil®

APPLICATION NOTE

Application

Unique properties of **NanoFoil®** enable the bonding of any combination of target and backing plate materials using any solder of choice.



Tiled ceramic target bonded to a copper backing plate.

NanoFoil® and Solder Selection

The appropriate thickness of **NanoFoil®** is determined by the thermal properties of the target, backing plate and solder. Indium Corporation's Application Engineering support will advise on the appropriate **NanoFoil®** product. The solder selection is determined by the user's needs and wetting characteristics of the target and backing plate. For most cases, solder from the SnAg family is recommended for its relatively high melting temperature (220ºC) and good strength (3600 psi shear strength). For difficult to wet target materials, including ceramics, Indium Corporation can advise on solder selection. These solders have been proven effective in wetting to and adhering to ceramics without the need for any metallization.

Surface Preparation

Before bonding with **NanoFoil®**, preparation of the target and the backing plate surfaces is necessary. These surfaces are pre-wet (pre-tinned) with solder on a hot plate. Easy to wet surfaces such as copper can be pre-wet with conventional SnAg based solders and a flux. Hard to wet surfaces can be pre-wet with Indium Corporation's recommended solders and application methods. The flatness of the pre-applied solder layers will determine the quality of the bond. For very high quality bonds with >98 % coverage, machined solder layer surfaces are recommended. Acceptable quality bonds with 90-95 % coverage can still be achieved without machining.

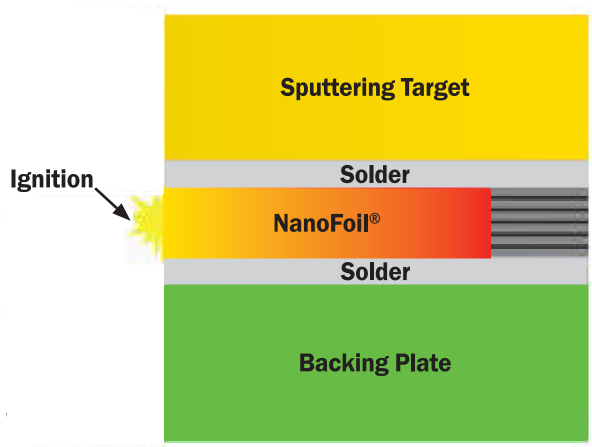
Advantages of NanoBond®

	NanoBond®	Elastomer Bond	Indium Bond
High Power Densities	✓✓✓	✓✓	✓
Thermal/Electrical Conductivity	✓✓✓	✓	✓✓✓
Strength	✓✓✓	✓✓	✓
Flatness and Uniformity	✓✓✓	✓✓	✓

Bonding Procedure

Bonding with **NanoFoil®** is a room temperature process in air. The backing plate is laid flat with the pre-tinned surface up. **NanoFoil®** is then placed on top of this solder surface. The **NanoFoil®** can be in the form of a single piece for smaller sputter targets or in the form of a pre-assembled array for larger sputter targets. The target is then positioned over the **NanoFoil®** and aligned correctly with the backing plate. A cross-section of this layout is shown schematically below.

Once the backing plate, **NanoFoil®** and target are correctly positioned with respect to each other, pressure (50-350 psi) is applied to the assembly. The reaction in the **NanoFoil®** is initiated by an electrical impulse (at multiple points simultaneously for large targets) and is complete in a few milliseconds. The heat generated by the **NanoFoil®** reflows the solder layers on the backing plate and the target and a bond is instantly formed. The bond is stress-free since the backing plate and target do not heat up to any great extent during the bonding operation. Strengths of 3000-4000 psi are typical. Bond coverage is between 90 and 99%, depending on surface preparation methods.



Schematic showing heat released by NanoFoil® to melt solder and bond (NanoBond®) sputtering target to backing plate.

OVER→

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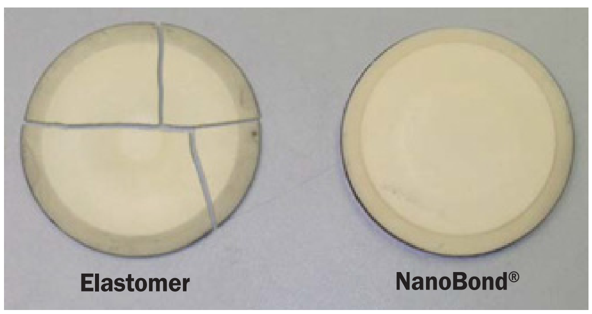
Performance Data

Summary of sputtering trials (all targets bonded to copper backing plates)

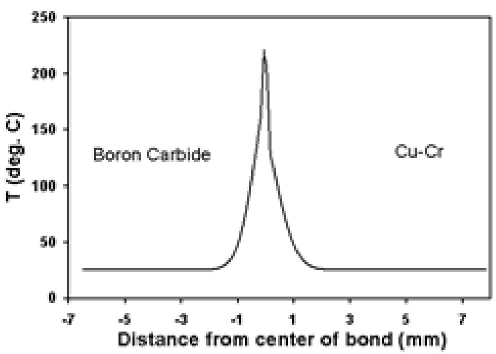
Target Material	Power Mode	Bond Type	Max. Power without Failure (W)	Power Density (W/cm^2)
Indium Tin Oxide	DC	InSn Reflow	200	4.4
Indium Tin Oxide	DC	Elastomer	300	6.6
Indium Tin Oxide	DC	NanoBond®	400	8.8
Alumina	RF	Elastomer	300	6.6
Alumina	RF	NanoBond®	400†	8.8†
Boron Carbide	DC	In Reflow	2000	2
Boron Carbide	DC	NanoBond®	4000†	4†

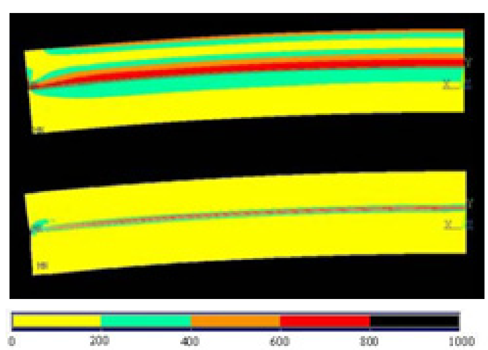
†Conservative values, not run to failure.



Alumina (3-inch diameter) targets after sputtering trials.

Residual Stress Calculations





FEA modeling of conventional and NanoBond® joints. The temperature profile of the NanoBond® joint at the moment of solder solidification is shown on the left (computed by finite difference calculations and used as an input for FEA). The strain energy of the NanoBond® joint (bottom right) is ⅛ that of the conventional bond (top right) and deflection is an order of magnitude less.

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