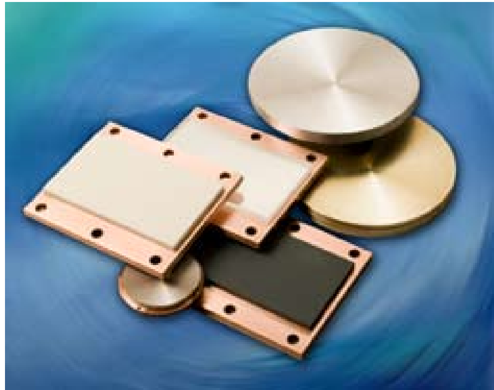
RNT

Reactive NanoTechnologies

NanoFoil® and NanoBond®

The Complete Solution for Sputter Target Bonding

NanoFoil® and NanoBond®
The Complete Solution for Bonding Sputter Targets



Sputter Target Bonding with NanoFoil® and NanoBond® enables stress-free bonding of a wide variety of target and backing plate materials using high melting temperature solders.

Reactive NanoTechnologies, Inc. (RNT) has developed its patented NanoFoil® and NanoBond® process to meet and exceed performance expectations in a wide variety of thin film deposition applications. As a revolutionary method of bonding sputter targets, NanoBond® offers the most comprehensive performance features and benefits to the end user.

Features

- Room temperature bonding
- Uniform bondline thickness
- High melting temperature solder
- Minimized stress from CTE mismatch
- Minimal voiding - up to 99% coverage

Benefits

- Superior high temp performance
- Enables higher sputtering rates
- Uniform film deposition
- Increased yield
- Improved reliability
- Increased operational uptime
- Increase in manufacturing throughput

Applications

The use of physical vapor deposition has continued to grow at tremendous rates. Applications for this core manufacturing technology continue to expand as materials and process advancements are developed.

Today, NanoFoil® and NanoBond® are providing real world benefits to suppliers and end users alike. Applications that have been able to realize these benefits include:

- Semiconductor Wafer Processing
- Large Screen LCD Displays
- Solar Cell Manufacturing
- Thin Film Recording Heads
- Magnetic Storage Media
- Optical Storage Media
- Optical Coatings
- Wear Resistant Coatings
- Architectural Coatings
- Reflective/Lighting Coatings

Technology

NanoFoil® enables a high quality, high melting temperature solder bond between a sputtering target and a backing plate. The NanoBond® process allows the user to increase sputtering rates by 30-100%. NanoBond® produces a strong, flat, low stress bond that is highly thermally and electrically conductive. NanoFoil® works by acting as a local heat source to melt adjacent solder layers without heating the target or backing plate materials. This allows the bonding of nearly any combination of sputter target material and backing plate material, including ceramics to metals, irrespective of the difference in coefficient of thermal expansion (CTE).

Material

RNT's patented NanoFoil® is a new class of nano-engineered material, typically fabricated by vapor depositing thousands of alternating nanoscale layers of aluminum (Al) and nickel (Ni). When activated by a small pulse of energy from electrical, optical or thermal sources, the foil reacts to precisely deliver localized heat.

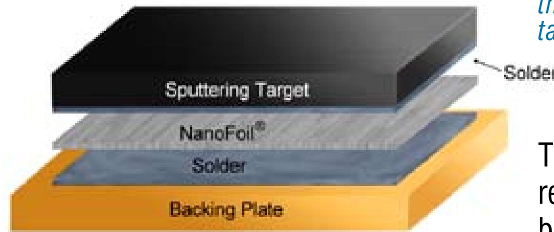
Bonding Sputter Targets with NanoFoil®

NanoFoil® and Solder Selection

The appropriate thickness of NanoFoil® is determined by the thermal properties of the target, backing plate and solder. Application Engineering support by RNT will advise on the appropriate NanoFoil® product. The solder selection is determined by the users needs and wetting characteristics of the target and backing plate. For most cases, solder from the Sn or SnAg family is recommended for its relatively high melting temperature (220ºC-232ºC) and superior mechanical properties. For difficult to wet target materials, including ceramics, RNT will advise on solders that have been proven effective in wetting and adhering to ceramics without the need for additional metallization.

Bonding Procedure

NanoBonding with NanoFoil® is performed in air at room temperature. 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 as a pre-assembled array for larger sputter targets. The pre-tinned 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, pressure 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.

Unique properties of NanoFoil® enable the bonding of nearly any combination of target and backing plate materials.

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 experience little heating during the bonding operation. Strengths of 3000-4000 PSI are typical. Bond coverage is between 95 and 99 %.

Used silicon sputter target, bonded with NanoBond® process.

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

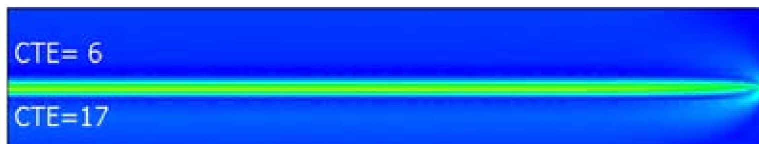
Performance Data

Summary of sputtering trials (all targets bonded to Cu backing plate)

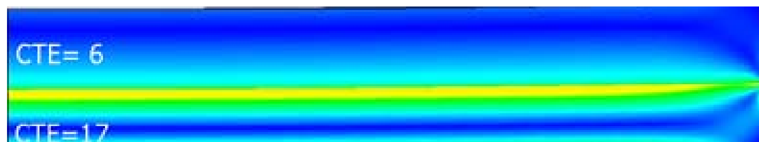
Target Material	Bond Type	Power Mode	Cooling	Bond Area	Max. Power without Failure (W)	Power Density (W/cm^2)
Indium Tin Oxide	InSn-Revlow	DC	Indirect	3" Diameter	200	4.4
Indium Tin Oxide	Elastomer	DC	Indirect	3" Diameter	300	6.6
Indium Tin Oxide	In Reflow	DC	Indirect	3" Diameter	335	7.3
Indium Tin Oxide	NanoBond®	DC	Indirect	3" Diameter	460	10.1
Alumina	Elastomer	RF	Indirect	3" Diameter	300	6.6
Alumina	NanoBond®	RF	Indirect	3" Diameter	400*	8.8*
Quartz	NanoBond®	RF	Indirect	3" Diameter	400*	8.8*
TiC	NanoBond®	DC	Indirect	3" Diameter	400	8.8
Boron Carbide	In Reflow	DC	Indirect	25" x 6"	2000	2
Boron Carbide	NanoBond®	DC	Indirect	25" x 6"	4000*	4*
**Not run to failure*						

Residual Stress Calculations

FEA modeling of conventional and NanoBond® joints. The deflection and residual stress are an order of magnitude lower with NanoBond®.

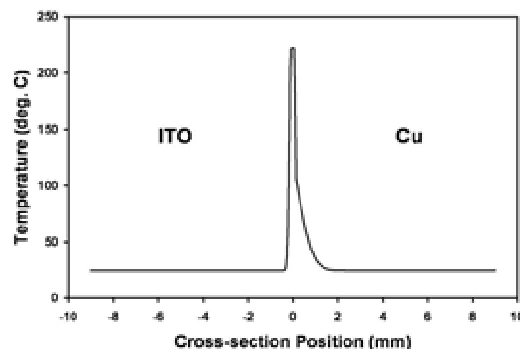


NANOBOND®
Maximum deflection - 0.04mm over 150mm



CONVENTIONAL BOND
Maximum deflection - 0.7mm over 150mm

The temperature profile during NanoBond® joining at the moment of solder solidification is shown on the right.



Cross-section Position (mm)

RNT
Reactive NanoTechnologies

111 Lake Front Dr.
Hunt Valley, MD 21030

410.771.9801 ph
410.771.0586 fx

www.rntfoil.com