NanoBond: Target Bonding for Optimum Sputtering Performance

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NanoBond® offers an improved method for bonding sputtering targets to backing plates. It utilizes a metallic foil, NanoFoil®, to generate localized heating during bonding. The heat is so precisely controlled that, while it is sufficient to reflow solder layers, it does not heat up the target or backing plate. Stress-free bonding of any combination of materials using high melting temperature solder is therefore possible. NanoBond thus offers many advantages compared to conventional bonding processes.

Before bonding with NanoFoil, some preparation of the component surfaces is necessary. The surfaces are usually pre-wet (pre-tinned) with solder on a hot plate. Easy-to-wet surfaces such as copper backing plates can be pre-wet with conventional tin-silver based solders and a flux. Hard-to-wet surfaces, including ceramic targets, can be pre-wet with RNT-recommended proprietary solders and application methods. Bonding with NanoFoil is performed at room temperature, in air. To bond, one component 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 bonding areas, or in the form of a pre-assembled array for larger bonding areas. The other component is then positioned over the NanoFoil and aligned correctly with the backing plate. A cross-section of this layout is shown schematically in Figure 1. After alignment, pressure (50-450 PSI) is applied to the assembly. The reaction in the NanoFoil is initiated by a single electrical spark (or at multiple points simultaneously for large bonding areas) and is complete in a few milliseconds. The heat generated by the NanoFoil reflows the solder layers on the components and a bond is instantly formed. Unique to NanoFoil, the heat is controlled to such an extent that the components do not heat up to any great extent. The resultant bond, termed NanoBond, is stress-free due to this lack of heating of the components that prevents the normal expansion and contraction of components and so large CTE mismatches between target and backing plate materials are not a concern.

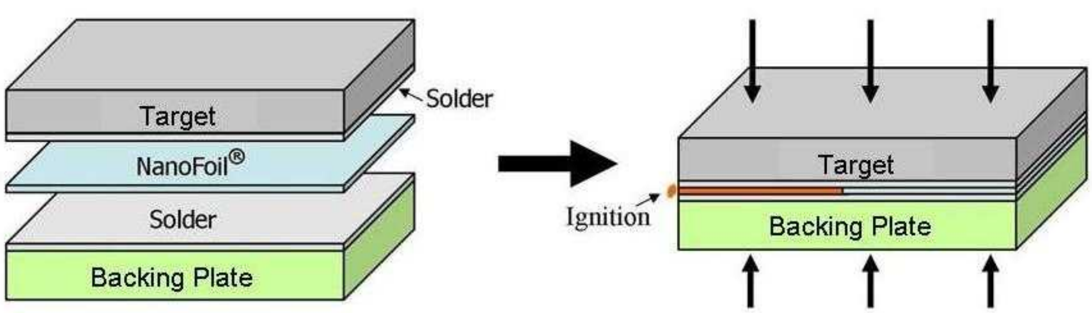

Figure 1: NanoBond process. NanoFoil is inserted between a target and a backing plate that have previously been pre-tinned with solder. The assembly is brought together and a load applied. The NanoFoil is ignited with a small electrical spark, releasing heat that is sufficient to melt the solder layers, but controlled to prevent heating up of the components.

Properties of NanoBond

Due to the prevention of the normal expansion and contraction cycles encountered during conventional target bonding, NanoFoil can enable solder bonds other than indium. Tin based solders are thus usually chosen for the NanoBond process and offer many advantages over indium solder. Firstly, tin based solders have a significantly higher melting temperature. For instance, the eutectic SnAg alloy (96.5Sn-3.5Ag) has a melting temperature of 221 ºC compared to 157 ºC for pure indium. This means that sputtering targets bonded by NanoBond can be run hotter (at higher sputtering powers) before the bond fails compared to sputtering targets bonded with indium. NanoBonds also have very high strengths. Measured shear strengths of 3600 psi are typical. Futhermore, NanoBonds have good thermal and electrical conductivities and they have been shown to survive the stresses induced by thermal cycling typical of a sputtering process that powers up and down. Bond coverage of NanoBonds is also very good as quantified by ultrasonic scanning. Void contents are typically 1 – 5 % of the total bond area. A full summary of the properties of NanoBonds is given in Table 1.

Table1: Properties of NanoBond using SnAg solder compared to other methods

	Elastomer	**Indium**	**SnAg NanoBond**
Temperature Limit (ºC)	250	157	221
Thermal Conductivity (W/mK)	0.75	83.7	40
Electrical Conductivity (106S/m)	0.0021	13.9	9.3
Shear Strength (psi)	461	310	3600
Vapor Pressure (Torr)	Less than 1% TMC @ 150ºC @ 10-7 Torr for 24 hr)	10-8 @ 487 ºC 10-6 @ 597 ºC 10-4 @ 742 ºC	10-8 @ 682 ºC 10-6 @ 807 ºC 10-4 @ 997 ºC
Thermal Shock			Survived MIL-STD-810: Cycle between -51 ºC and 71 ºC
Bond Coverage (as measured by ultrasonic scanning)			95-99 %