NanoBond® Sputter Target Bonding with NanoFoil®

ITO Case Study

Three identical Indium Tin Oxide (ITO) sputtering targets (7.6 cm diameter) were bonded to copper backing plates using three different bonding processes:

1. Conventional reflow of InSn solder (performed by a contract bonder)
2. Elastomer bonding (performed by a contract bonder)
3. NanoBond® using NanoFoil® as a local heat source to melt a SnAg type solder (performed by RNT)

The three bonded ITO targets were then run sequentially in the same magnetron cathode under DC power. The power was ramped up in 100 W increments, holding for a minimum of 1 hour at each power setting to observe stable sputtering performance. A summary of each target's performance is given in Table 1 below. The target bonded with InSn solder using a conventional reflow process failed while ramping from 200 W to 300 W, when the InSn solder melted and dripped out of the bond, thereby shorting to the anode. Thus the maximum sustainable power recorded for this target was 200 W. The target bonded with elastomer started to exhibit small cracks when the power was ramped up from 200 W to 300 W, but seemed to remain stable operating at 300 W. However, when the power was ramped from 300 W to 400 W, the cracks became larger (see Figure 1) and current and power readings did not stabilize. Eventually, pieces of the target fell off from the backing plate. The maximum sustainable power recorded for this target was thus 300 W, but it must be noted that the target had already cracked at this stage. The target bonded by NanoBond® achieved the highest sustainable sputtering power. Conditions were stable at 400 W. At 500 W the SnAg solder melted and caused a short. In addition to a solder bond with good thermal conductivity and strength, the NanoBond® also has the advantage of using a high melting temperature solder, SnAg (T_m = 220ºC).

Table 1: Performance Summary of ITO targets

Bond Type	**Max. Power without Failure (W)**	**Power at Failure (W)**	**Max. Power Density (W/cm^2)**	**% Improvement (InSn baseline)**
InSn Conventional	200	300	4.4	-
Elastomer	300	400	6.6	50
NanoBond®	400	500	8.8	100

Figure 1: Photographs of ITO targets after sputtering trials

Alumina Case Study

Two identical alumina (Al_2O_3) sputtering targets (7.6 cm diameter) were bonded to copper backing plates using two different bonding processes:

1. Elastomer bonding (performed by a contract bonder)
2. NanoBond® using NanoFoil® as a local heat source to melt a SnAg type solder (performed by RNT)

The two bonded alumina targets were then run sequentially in the same magnetron cathode under RF power. The power was ramped up in 100 W increments, holding for a minimum of 1 hour at each power setting to observe stable sputtering performance. A summary of each target's performance is given in Table 2 below. The target bonded with elastomer started to crack at 300 W, but seemed to remain stable at this power. However, when the power was ramped to 400 W pieces of the target fell off from the backing plate (see Figure 2). The target bonded by NanoBond® performed better and was very stable at 400 W.

Table 2: Performance Summary of alumina targets

Bond Type	**Max. Power without Failure (W)**	**Power at Failure (W)**	**Max. Power Density (W/cm^2)**	**% Improvement (Elastomer baseline)**
Elastomer	300	400	6.6	-
NanoBond®	400	Not run to failure	8.8 (at least)	> 33

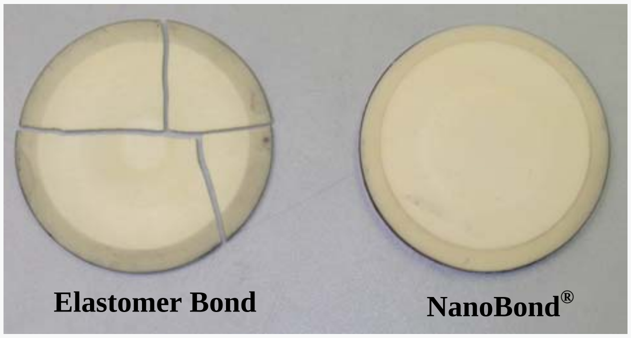

Figure 2: Photographs of alumina targets after sputtering trials

Boron Carbide Case Study

Two identical boron carbide (B_4C) sputtering targets (63 cm x 15 cm), consisting of four tile pieces, were bonded to copper backing plates using two different bonding processes:

1. Conventional reflow of In solder (performed by a target supplier)
2. NanoBond® using NanoFoil® as a local heat source to melt a SnAg type solder (performed by RNT)

The two bonded boron carbide targets were run sequentially in the same magnetron cathode at DC power under production conditions. The target bonded with conventional reflow of In solder was run at 2000 W. After less than 10 hours of use, cracks appeared in the boron carbide as shown in Figure 3 below and after about 100 hours one of the boron carbide tiles debonded from the backing plate. The target bonded with NanoBond® was run at 4000 W. After 200 hours at 4000 W no cracks developed and the boron carbide tiles remained well bonded to the backing plate.

Table 3: Performance Summary of Boron Carbide Targets

Bond Type	**Max. Power without Failure (W)**	**Power at Failure (W)**	**Max. Power Density (W/cm^2)**	**Sputtering Rate (μm/hr)**
Conventional In	2000	2000	2	1.1
NanoBond®	4000	Not run to failure	4 (at least)	2.3

Conventional In Bond **NanoBond®**

Figure 3: Photographs of boron carbide targets after sputtering use. Cracks in the conventional In bonded target are indicated by arrows

Cost Savings from Using a NanoBond® Sputtering Target

The use of a NanoBond® sputtering target can lead to a 30-100 % increase of sputtering rate (compared to a conventional In solder reflow bond or elastomer bond). This can consequently lead to significant increases in production efficiency. Since the equipment costs in many sputtering production processes are very high, this translates to big cost reductions per production cycle due to a lowering of overhead costs (especially capital equipment depreciation). For a typical webcoating process, an increase in throughput of 25 % could be achieved by halving the time spent on the ceramic coating part of the process. The overhead costs per production run would be reduced by a similar amount. A simple cost analysis shows that the savings can amount to $150,000-500,000 per year per sputtering system.