ANGSTROM SCIENCES

TEST REPORT: NON-BONDED CYLINDRICAL ITO

A single cylinder of Indium Tin Oxide (ITO) was tested with no bonding or interface between the ITO target material and the backing cylinder. The goal of the test was to determine if the cylinder had the structural integrity to withstand the process environment without chipping, breaking or forming nodules. The test ran for over 8 days, around the clock, with only intermittent breaks to inspect the target for any anomalies or non-conformities. The test included operation of the target at power densities up to 2.5 X those applied to non-bonded or bonded planar ITO.

The results of the test show the target successfully fulfilled these requirements. There were no signs of damage to the target associated with the process, regardless of the power level, and no nodules were found. We did ultimately damage the target due to our chamber configuration but this occurred at the end of the test and was definite in nature.

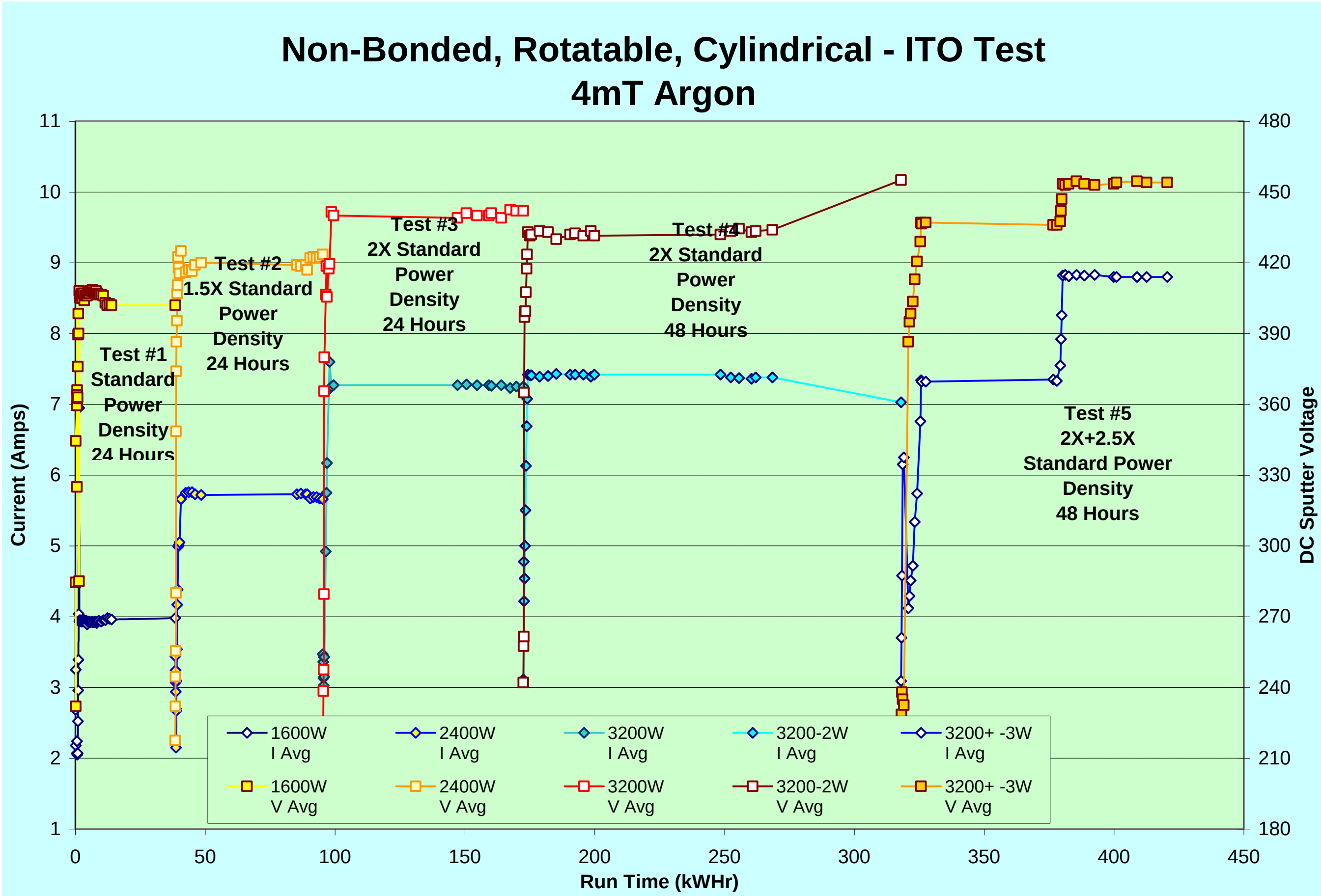
RESULTS:

1. One of the unique configurations of this test was that we operated the process in a horizontal mode with the cathode sputtering down.. This means that the ID of the ITO cylinders was a slip-fit over the backing tube and considering gravity, the target would most likely have no contact to the backing tube during transition through the plasma and on the backside of the plasma it would be in direct contact to the water cooled surface. The immediate concern was the thermal gradient between the plasma region and water cooled region but there were no identifiable issues found.

   It was also identified that due to thermal expansion, the ITO cylinder would grow in length and somewhat push away from the neighboring target material. This is not as much of an issue during the initial operation, but if the user were to stop the process allowing the ITO to cool, it would not return to the initial position thus leaving a gap to the backing tube. To accommodate this a spring loaded device was developed to keep a constant load on the ITO cylinders and assure there was no gap.

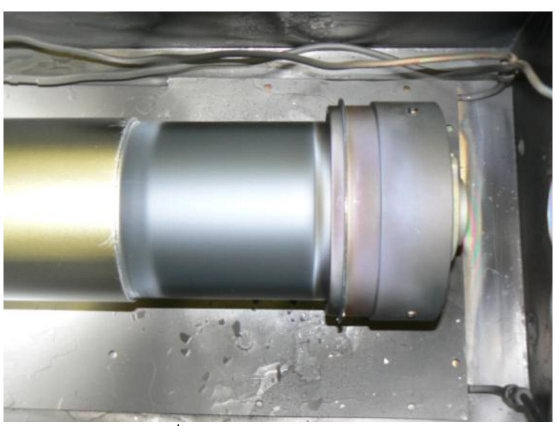
Although positioned vertically, the set-up configuration of the target assembly shows the device developed to keep a slight compression on the ITO cylinder so no gaps would be exposed.

2. The process ran at very consistent voltage and current levels during the process, even between venting the chamber, which implies the user can expect a very stable and repeatable process. The cathode was run over a period of 4 days at a power level of 2X what would be specified for the planar ITO process.

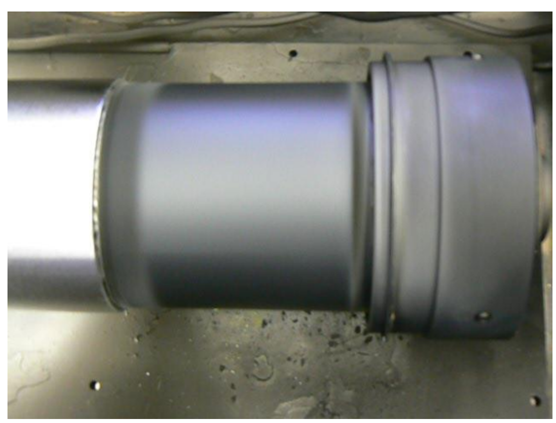


The above plot shows the IV parameters which the user might obtain by using the ITO cylinders with the Angstrom Sciences cylindrical magnetic.

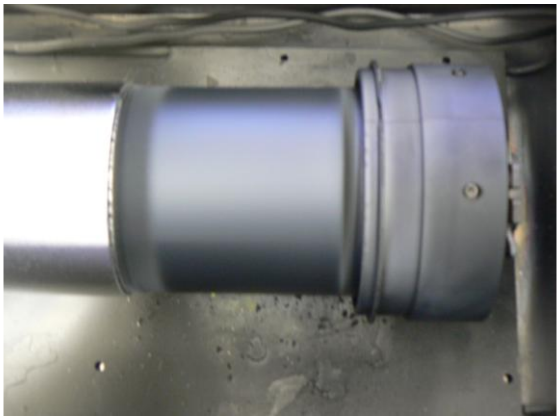
3. In between each break in the test, the target was examined for any nodules or structural faults, in which none were identified.



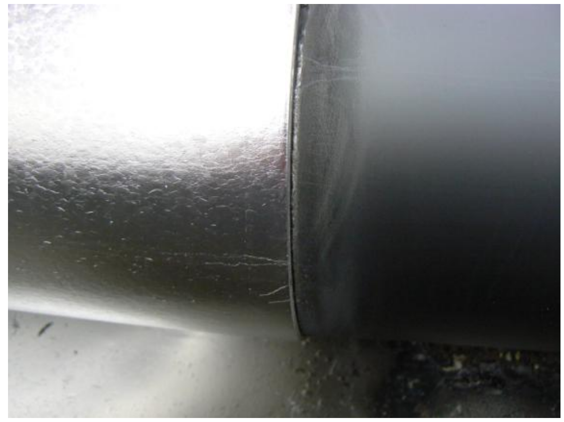
After the 1st day of testing the target is examined for any nodules or cracks. The only anomaly seen is the transition region between the single ITO cylinder and the adjacent metal



Day #2 Results, at 1.5X the power of a planar magnetron, the results for integrity and no nodules are the same as Day #1 target.



Continued excellent performance after Test #3 (2X power)



After the continuous 48 hours test, at 2X power, there is a small amount of ITO chipping seen at the interface between the ITO target and the metal target. This is attributed to the “rubbing” affect due to the ITO cylinder movement with rotation. The metal target is part of the backing tube construction and does not move with rotation.

After 7 days of testing, 24 hours of operation per day, the ITO cylinder is still clean of any nodules or signs of cracking. This last day of test was conducted at 2.5X power

4. Although there were no samples attempted with this initial test, we were surprised to calculate a very significant increase in the actual deposition rate. Angstrom Sciences typically uses a value of 2800 associated with the ITO deposition in order to determine rate in a dynamic or moving substrate fashion. By measuring the target diameter and recalculation, estimates for the actual deposition rates jumped to as high as 5400. If accurate, this result suggests that a single cylindrical ITO target sputtering at 2.5X the power density of a planar target, can deposit material at the equivalent speed of over 4 planar cathodes!

CONCLUSION:

A process and hardware solution has been developed which supports the operation of non-bonded ITO at significant incremental power. The ITO cylindrical non-bonded target in test was able to sputter, horizontally, at a power level of 2.5X the planar magnetron. Although preliminary in this testing stage, the deposition rate might also be increased to just less than 2X those rates seen for bonded target testing, but this must be verified on actual sample analysis.

Further to the hardware and process developments, a method of accommodating thermal expansion yet not allowing the targets to form gaps in the joints has been developed.

These preliminary tests show more than great promise for commercialization of non-bonded rotatable ITO cylinders. To complete the final pieces of the program, a full ITO target must be sputtered onto substrates to show:

- Optical properties of the ITO are retained
- Electrical properties of the ITO are retained
- Deposition rate IS enhanced by a factor of almost 2 for this new process.

Aside from the power and deposition rate advantages, it must also be realized this process offers the customer the following advantages:

- 100% easy and quick reclamation and recycle of all unused ITO
- The customer does not have to ship target tubes out to a vendor (incurring the shipping cost) and wait for 6-8 weeks or more for the target to be fabricated and bonded. The customer can order a surplus of ITO cylinders and replace the target, in house, in typically an hour or less of time.
- The non-bonded ITO cylinders save the customer several thousands of dollars of non-recoverable bonding costs, and, the single backing tube can be reused for several target sets.