Test Report: Non-Bonded Cylindrical AZO – Structural Integrity

A single cylinder of Aluminum Zinc Oxide (AZO) was tested with no bonding or interface between the AZO 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 14 days, around the clock on each test, with only intermittent breaks to inspect the target for any anomalies or non-conformities and weekends. The test included operation of the target at power densities up to those applied to bonded cylindrical AZO.

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. The test ended when we completely eroded through the entire wall thickness of the AZO cylinder.

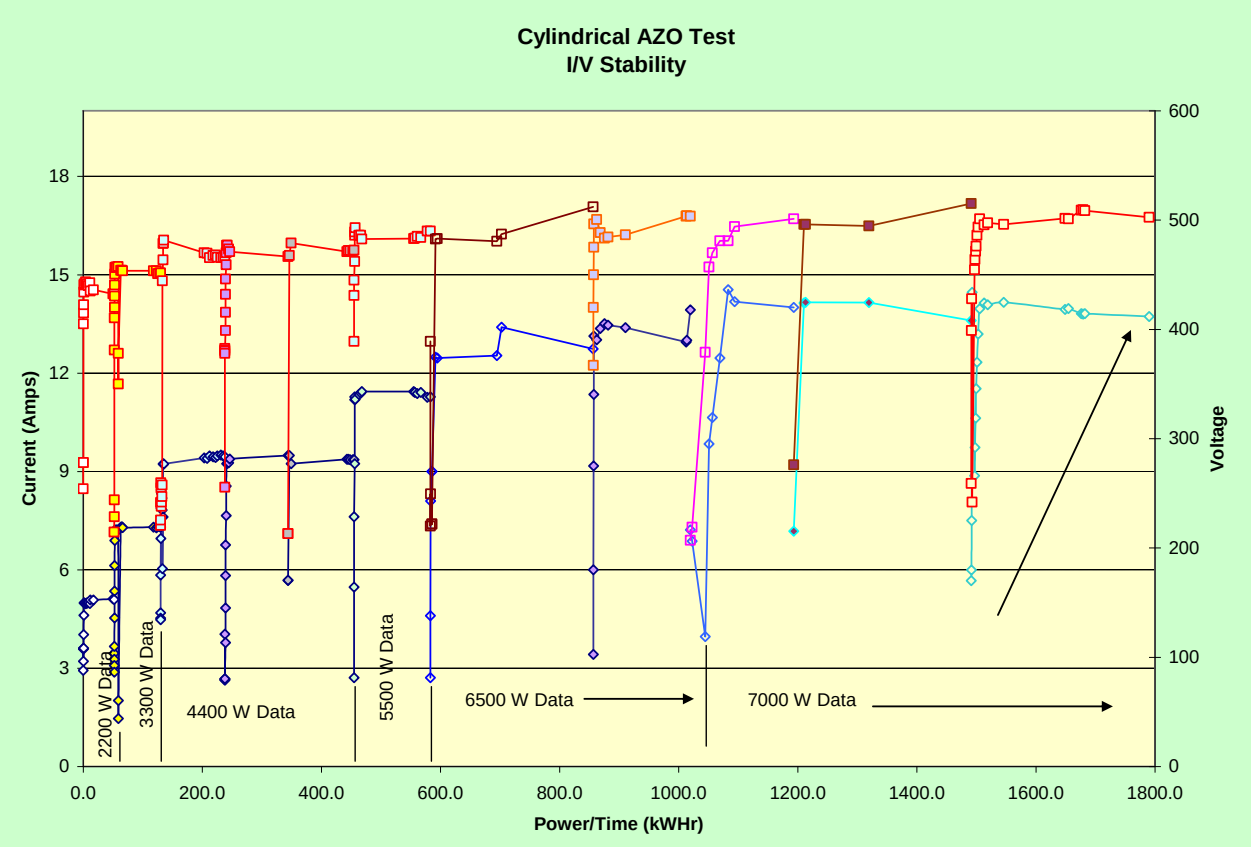
RESULTS:

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 AZO 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 AZO 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 AZO 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 AZO cylinders and assure there was no gap.

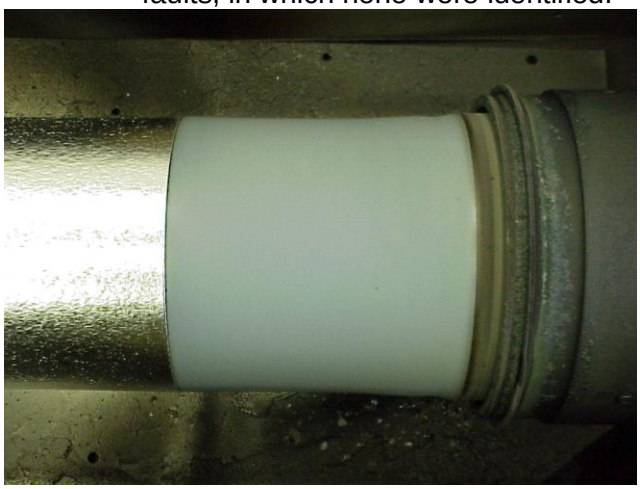
Although positioned vertically, the set-up configuration of the target assembly shows the device developed to keep a slight compression on the AZO cylinder so no gaps would be exposed.

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 5 days, within this test, at a power level of equivalent to what might be specified for a bonded AZO process. Higher power densities than bonded products were not tested.

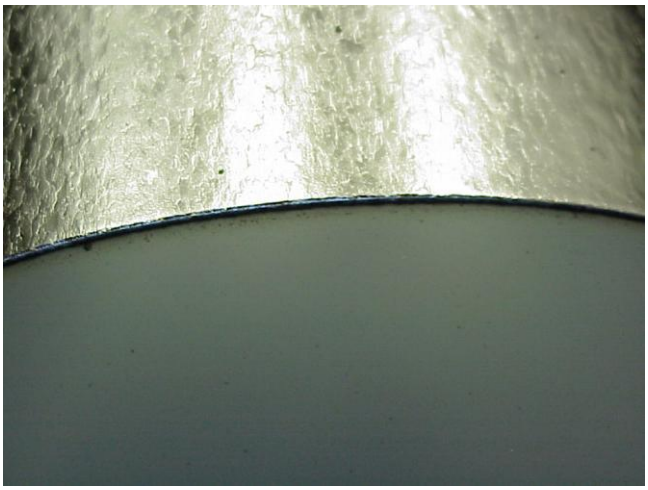


The above plot shows the IV parameters which the user might obtain by using the AZO cylinders with the Angstrom Sciences cylindrical magnetic.

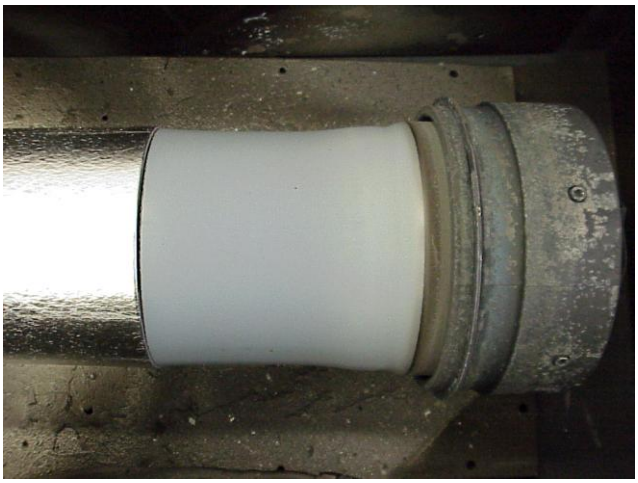
3. In between each break in the test, the target was examined for any nodules or structural faults, in which none were identified.



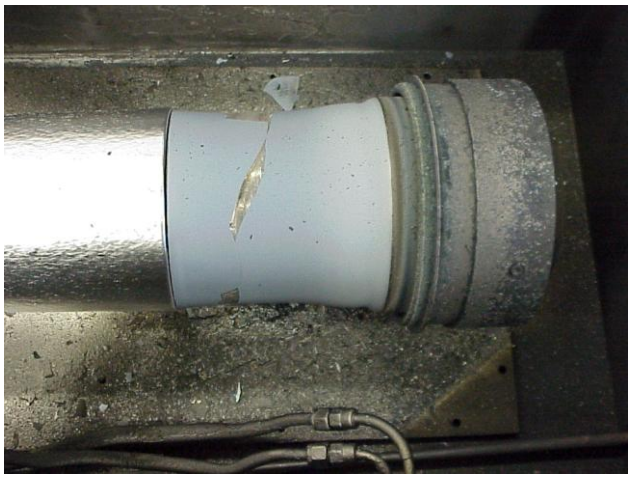
After testing at 6500W the target is examined for nodules and cracks. The only anomaly seen is the transition region between the single AZO cylinder and the adjacent metal target.



The AZO cylinder is also examined for chipping or breaking around the edges where it adjoins the aluminum backing tube/target assembly.



The target performance met all criteria for structural needs and no nodule growth, as seen here on the 2nd to last day of test



The target sputtered very stable until the last day when we broke through the wall thickness and the experiment was ended

4. Although there were no thin film samples attempted with this initial test, we were able to estimate the deposition rate by measuring the target diameter after each test. By a very rough and not so accurate backwards calculation, estimates for the actual deposition seemed to be stable at all power levels at about 4200DDR.

CONCLUSION:

A process and hardware solution has been developed which supports the operation of non-bonded AZO at significant incremental power. The AZO cylindrical non-bonded target in test was able to sputter, horizontally, at a power level equivalent to bonded cylindrical AZO. The deposition rate is believed to remain constant throughout all levels of power testing.

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 AZO cylinders. To complete the final pieces of the program, a full AZO target must be sputtered onto substrates to show:

- Optical properties of the AZO are retained
- Electrical properties of the AZO are retained
- Deposition rate IS stable.

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 AZO
- 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 AZO cylinders and replace the target, in house, in typically an hour or less of time.
- The non-bonded AZO 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.