

August, 2002

Dear Customer,



The trials and tribulations of sputtering ferro-magnetic target materials - solved!

Ferro-magnetic target materials and magnetrons don't mix! There is one simple reason for this, the magnetic field created to confine the electrons in the magnetron plasma is absorbed by target material itself. Depending upon the properties of the material this can cause a greater or lesser problem (see figure 1)

One problem is the restrictions of the thickness of the target. Depending upon the magnetic saturation of the material, the thickness of the material will need to be limited to a level that still enables a sufficient magnetic field (200-250 Gauss) to be projected over the target surface to maintain an efficient sputtering plasma. When the target thickness is limited, then the need to change the target more frequently leads to poor machine up-times which can be critical in some applications.

Element	At. Mass (amu)	Magnetic Saturation			Magnetic Moment (μB)	T Curie ($^{\circ}\text{C}$)	Target Thick (Typical)
		@20 $^{\circ}\text{C}$ ($\mu\cdot\text{g}^{-1}$)	radii @20 $^{\circ}\text{C}$ (a.u.)	@0 $^{\circ}\text{C}$ ($\mu\cdot\text{g}^{-1}$)			
Fe	55.847	218	3.5	221.9	2.219	770	1-2mm
Co	58.933	161	2.9	162.5	1.715	1131	3-4mm
Ni	58.71	54.39	1	57.50	0.604	358	3-8mm

Figure 1

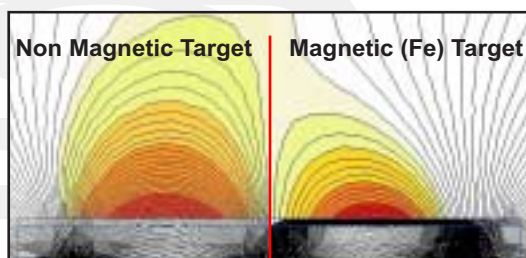
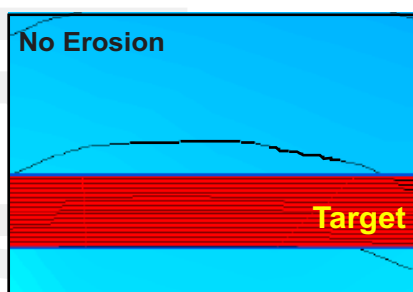


Figure 2 - 2mm thick Target
(Left : Non Magnetic Target, Right : Fe Target)

The strength of the magnetic field generated can be increased to maximise the target material thickness. But as can be seen from figure 2, for material such as iron (Fe), even with extremely high magnetic field strengths the target thickness can be severely limited. One other more practical problem is how to get the target material on / off with such a high magnetic attraction to the source. Sore fingers maybe the least of your problems!



The second problem with conventional approaches to sputtering ferro-magnetic target is the target utilisation is low compared to non-magnetic targets. The reason is the effect of the shape of the target erosion on magnetic field profile over the target surface. As the target erodes locally more in the centre of the race-track, there is less ferro-magnetic material there to absorb the field. Hence there is a local increase in magnetic field there (see figure 3).

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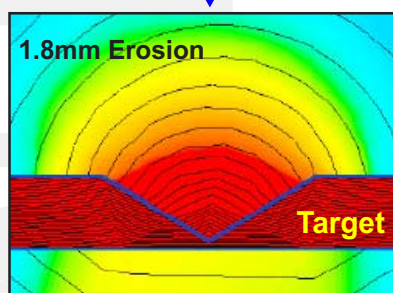
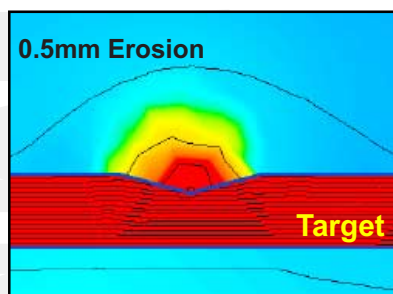


Figure 3 (2mm Fe Target)

This is a self propagating problem since the more material is sputtered the higher the rise in field strength locally and hence the more enhanced the erosion at one point becomes. This is commonly referred to as **pinching** of the plasma and leads to target utilisations of only 5-15% depending upon target material. The pinching can be counteracted with magnetic shunt plates behind the target, however, this further restricts target

So the problems are considerable and most users have to tolerate the very poor process efficiency of sputtering magnetic target materials.

So, how about some end to the misery! Well, one option is manipulation (movement) of the magnetic field behind the target. This is a conventional approach, but can be used to move the plasma around to alleviate the **pinching** effect. A well designed source can produce high target use (>40%), but the cost of the solution is high since there is the cost of the magnet manipulation with the added problem of the high magnetic attraction to the target. But again magnet manipulation does not solve the restricted target thickness problem.

GENCOA have developed what we call the LOOP or LP magnetron. The patent is still pending on this design, hence **full** details cannot be shown. But its ready for exploitation and we have started marketing and selling it.

The LOOP magnetics basically overcomes all the usual problems of sputtering magnetic target materials. The basic facts are that very thick targets can now be used. For example up to a 12mm or 1/2" thick iron (Fe) target can be used on a 6" wide cathode. The thickness for Nickel can be at least double that (1"). But more importantly, the target utilisation is high (35-45%). So the target use is now in excess of conventional two pole magnetic system for non-magnetic materials (25%) and is in line with enhanced multi-pole magnetic systems such as the **GENCOA** High Yield (HY) type (>40%).

So in terms of performance the sputtering of ferro-magnetic target materials can be economic as all other sputter processes. If a comparison is made for Fe, the new loop design on a 6" wide cathode offers 20-30 times longer target life. The actual magnetron source cost no more than a conventional high strength magnetron.

It was recently introduced at one of our customers sites and here is an extract from their email:



Figure 4
(GENCOA HY Erosion Example)

"...the new system is fantastic. The performance far outstrips our most optimistic expectations, you guys really know what you are doing"

Commented by Dr. Ian Anderson
(Institut Max Von Laue - Paul Langevin [ILL], France)

If you are working with these target materials, then please don't hesitate to contact us regarding improving your lot in life! More good news is that it may also be used on existing cathodes that we can modify, so the expense of completely new sources can be avoided.

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■ An Aside on Power Supplies

Gencoa currently have a number of Advanced Energy, MDX power supplies for sale. They came from one of our **blue chip** customers and have been **serviced** by Advanced Energy before sale. The power supplies details are as follows:

Model	Input Voltage	Front Panel	Availability	Price
MDX 10kW	208 V	Passive	6 off	£2200
MDX 10kW	415 V	Passive	3 off	£2000
MDX 10kW - Modified with enhanced arc suppression (pulsed output)	415 V	Passive	3 off	£2400

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