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Details

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Magnetron Cathode (Angstrom)

【2017】

北京时代天启真空科技有限公司

Beijing Timestorch Vacuum Technology Co.,Ltd.

电 话：【15010907160】 联系人：【张照薪】 地 址：【北京市朝阳区天朗园 C 座 3 层丰收孵化器园】
传 真：【010-52818165】 邮 箱：【alexzhang@timestorch.com.cn】 网 站：【www.timestorch.com.cn】

We will continuously provide our customers with all-around and innovative vacuum technology solutions and services.

Content

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Cylindrical Magnetron Cathode

Angstrom offers state-of-the-art magnetrons for virtually any standard sputtering process. But we know that every application is different. That's why we've developed a unique, modular approach that specifically adapts to your specifications.

Cylindrical Magnetrons have long been trusted in the glass coating industry to create uniform thin films while maximizing target utilization. Now, Angstrom has created a compact, lightweight, and economical cylindrical magnetron specifically designed to offer these same advantages to I Laboratory,Flat Panel Display, Solar Cell, and Web Coating applications.

Custom Designs

Complete assemblies are available from 3" to 6" in target diameter.

Economical and Fully-Compatible Investment

The ONYX-Revolution™ utilizes a universal and cost-effective magnet design with customized turnarounds to fit any target type. And, it is designed with off-the-shelf components for low-cost, long-term investment and reliability.

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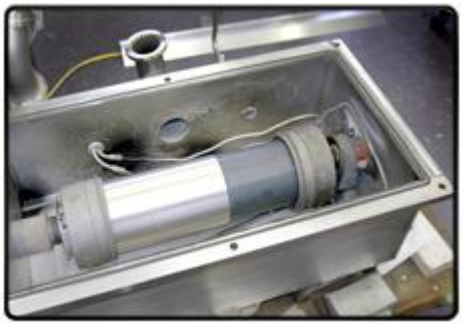
Patented Technology

Angstrom patented profiled magnet technology creates a deposition profile that is closer to normal between the source and the substrate. The improved deposition profile offers reduced debris accumulation on the chamber walls.

Additionally, Angstrom magnet array offers a higher magnetic field intensity, which allows the user to run the sputtering process at lower power to achieve typical deposition rates.



Translated Savings

Inherently, Cylindrical Magnetrons can hold up to three times the amount of target material as a planar magnetron with the same spatial area. Angstrom ONYX-Revolution™ further optimizes material investment with up to 85% target utilization. Plus, operating at lower power levels results in a typical power savings of 20%.

Total Commitment

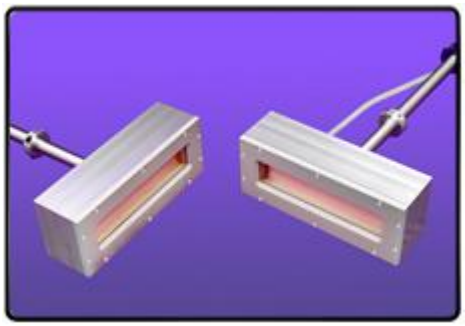
Angstrom is dedicated to helping our customers develop the most productive and cost-effective thin film applications by providing the world's most advanced magnetrons, high quality deposition materials, and comprehensive technical support. And we stand ready to ensure your satisfaction.

Linear Magnetron Cathode

As more industries discover the speed, controllability, and bottom-line benefits of magnetron sputtering, Angstrom is developing tools to maximize the output of these larger, faster manufacturing processes.

Broader Solutions

For those who have to coat extremely broad substrates or have to achieve extremely high throughput, linear magnetrons offer the perfect solution.



Patented Advantages

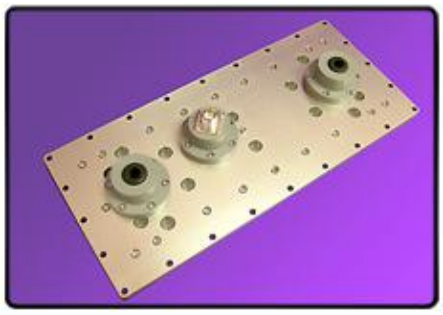
Linear magnetrons incorporate our fully-encapsulated patented profiled NdFeB rare earth magnets and turbulent water flow to provide unparalleled

Standard Fittings

We use ISO NW standard fittings, as well as Conflat® metal seal flanges. All utilities are maintained at atmosphere and accessed through standard O-ring compression fittings for easy installation in any vacuum system.

Total Power Compatibility

Low-impedence heads provide RF, DC, mid-frequency DC, pulsed DC, and microwave power compatibility.



Proven Performance

These magnetrons deliver the unparalleled performance that has made Angstrom the new standard of the industry.

Standard operation at extremely low pressure and exceptionally high power, provides you with the perfect balance of uniformity, utilization and rate in any application.

Going to any Length

Linear cathodes are available in a full range of target widths from 1.5" to 16" and lengths up to 12 feet. And, of course, we are fully-equipped to design and build custom magnetrons for any of your production needs.

Total Commitment

Magnetrons are guaranteed against defects in workmanship and materials for two full years. Magnetrons are our core business, and we stand ready to ensure your satisfaction.

Circular Magnetron Cathode

Circular magnetrons have become recognized as the new standard of the sputtering industry, because in addition to the advanced features of the Angstrom Advantage™, they offer a host of other performance advantages as well.

Versatile, Compact Design

Their compact design makes our circular magnetrons ideal for any new or retrofit application, including the most complex cluster assemblies for the smallest vacuum chambers.

Total Power Compatibility

Low-impedence heads provide RF, DC, mid-frequency DC, pulsed DC, and microwave power compatibility.

Standard Fittings

We use ISO NW standard fittings, as well as Conflat® metal seal flanges. All utilities are maintained at atmosphere and accessed through standard O-ring compression fittings for easy installation in any vacuum system.

Full Range of Sizes

Circular magnetron sources are available from 1 through 16 inch target diameters in either standard or custom configurations.

Quick, Easy Target Change

Our patented threaded target clamp and anode shield allow you to change targets without the use of ancillary tools. Their built-in adjustability also lets you fit targets of varying thickness without resorting to spacing devices.

Lower, Pressure, High Power

ONYX® magnetrons can operate at extremely low pressure (down to the 10-4 Torr range), and our direct cooled designs can deliver power densities up to 250 watts/in2 (30 watts/cm2).

High Rates and Performance

With higher power densities, you can coat a substrate faster. So Angstrom maximizes both your coating zone and your target utilization (usually in the 40% range) without a trade-off in rate.

Greater Uniformity

Thanks to our patented profiled magnets, our magnetrons also deliver much greater uniformity of deposition - routinely in the ± 3-5% range.

Total Commitment

All magnetrons are guaranteed against defects in workmanship and materials for two full years. Magnetrons are our core business, and we stand ready to ensure your satisfaction.

UHV Sputtering

Angstrom Sciences offers a full line of UHV magnetron design options including our “Onyx UHV” which features all metal seals and ceramic insulators and is bakeable. The “Onyx UHV” is available in 2”, 3”, and 4” diameters and is compatible with all of the accessories, magnet sets, and features found in both the standard Onyx cathodes (Kel-F insulators and 3 Viton® seals exposed to vacuum) and the “Onyx-HT” (a high temperature variant of the standard Onyx cathode with all ceramic insulators for high temperature operation and 1 Viton® seal exposed to vacuum which also introduces “near”-UHV performance). Angstrom Science also offers our “Onyx Classic UHV” which features demountable magnets.

These magnetrons are compatible with both DC , RF and pulsed power supplies. A full range of options are also offered including insertion lengths, shutters, gas inlets, and cross contamination shields.

HiPIMS – Magnetron Sputtering

HIPIMS sputtering stands for High Power Pulsed Magnetron Sputtering. This relatively recent advance in pulsed sputtering using very high power, short duration pulses of power to both generate a plasma and ionize a large percentage of the sputtered atoms.

It has been shown that precise control of the intensity of the magnetic field at the target surface is critical for the HIPIMS process for both the reduction of arcing and optimum ionization of the sputtered material.

Angstrom has developed solutions for both their circular and linear magnetron product lines that permit the magnetic field to be either varied discretely (though interchangeable magnet sets for internal mount cathodes) or continuously (through magnet pack height adjustments on external mount cathodes).

HIPIMS magnetrons are used for pretreatment of a sub straight prior to coating deposition and thin film depositions with high microstructure density.

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Magnetron Sputtering Targets & Materials

Magnetron Specifications

Specifications	ONYX-1	ONYX-2	ONYX-3	ONYX-4	ONYX-4 Direct	ONYX-5
Maximum Sputtering Power DC	150 W	1000 W	1.5 kW	2 kW	3.5 kW (2 kW Indirect)	2 kW
Maximum Sputtering Power RF	75 W	600 W	700 W	800 W	1.2 k W (700 W Indirect)	800 W
Cathode Voltage	100 to 1000 volts	100 to 1500 volts	100 to 1500 volts	100 to 1500 volts	100 to 1500 volts	100 to 1500 volts
Discharge Current	0.1 to 1 amps	0.1 to 2 amps	0.1 to 3 amps	0.1 to 4 amps	0.1 to 7 amps	0.1 to 4 amps
Operating Pressure	1 to 50 milliTorr	0.5 to 50 milliTorr	0.5 to 50 milliTorr	0.5 to 50 milliTorr	0.5 to 50 milliTorr	0.5 to 50 milliTorr
Cooling Requirements						
Flow Rate @ Max. Power	0.2 GPM	0.75 GPM	0.75 GPM	1.0 GPM	2.0 GPM	1.0 GPM
Maximum Input Temperature	20℃	20℃	20℃	20℃	20℃	20℃
Max. Input Pressure [open drain]	60psig	60psig	60psig	60psig	60psig	60psig
Target						
Form	Circular/ Planar	Circular/ Planar	Circular/ Planar	Circular/Planar	Circular/Planar	Circular/Planar
Diameter	1.0"/25.4 mm	2.0"/50.8 mm	3.0"/76.2 mm	4.0"/101.6 mm	4.0"/101.6 mm	5.0"/127.0 mm
Thickness	0.010" - 0.125"	0.010" - 0.375" (.254mm	0.010" - 0.375" (.254mm	0.010" - 0.375" (.245mm -	0.010" - 0.500" (.254mm -	0.010" - 0.375"

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	(.254mm - 3.175mm)	- 9.525mm)	- 9.525mm)	9.53mm)	12.7mm)	(0.254mm - 9.53mm)
Cooling	Indirect	Indirect	Indirect	Indirect	Direct/Indirect	Indirect
Magnetic Enhancement	Profiled NdFeB	Profiled NdFeB	Profiled NdFeB	Profiled NdFeB	Profiled NdFeB	Profiled NdFeB
Weight (Approx; w/o options)	1 Pound	3 Pounds	4 Pounds	10 Pounds	26 Pounds	16 Pounds
Mounting						
Source	0.75" OD Tubing	0.75" OD Tubing	0.75" Tubing	0.75" OD Tubing	1.0" OD Tubing	1.0" OD Tubing
Water	0.190" OD Tubing	0.250" OD Tubing	0.250" Tubing	0.250" OD Tubing	0.375" OD Tubing	0.375" OD Tubing
Power Connector, DC	Type N, Ext. Threads	Type N, Ext. Threads	Type N, Ext. Threads	Type N, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads
Power Connector, RF	Type N, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads
Power Cable, DC	RG 142	RG 393	RG 393	RG 393	RG 393	RG 393
Power Cable, RF	RG 142	RG 393	RG 393	RG 393	RG 393	RG 393
Maximum Temperature	100℃	100℃	100℃	100℃	100℃	100℃
Source of Substance Distance	2 - 12"	2 - 12"	2 - 12"	2 - 12"	2 - 12"	2 - 12"
Construction						
Cathode Body	OFHC Copper	OFHC Copper	OFHC Copper	OFHC Copper	OFHC Copper	OFHC Copper
Anode	304/316 Stainless	304/316 Stainless	304/316 Stainless	304/316 Stainless	304/316 Stainless	304/316 Stainless

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	Steel	Steel	Steel	Steel	Steel	Steel
Insulator	CTFE	CTFE	CTFE	PTFE	PTFE	PTFE
Dimensions						
A	1.5"/38.1 mm	2.8"/71.1 mm	3.8"/96.5 mm	5.0"/127.0 mm	6.420"/163 mm	6.0"/152.4 mm
B	1.4"/35.6 mm	2.24"/56.9mm	2.25"/57.15mm	3.0"/76.2mm	4.375"/111.1mm	3.38"/85.9 mm
C	N/A	0.060"/1.5mm	0.060"/1.52mm	1.00"/25.4 mm	0.397"/10.08mm	2.38"/60.3 mm
D	0.75"/19 mm Typical	0.75"/19 mm Typical	0.75"/19 mm Typical	0.75"/19mm Typical	1.0"/25.4mm Typical	1.0"/25.4mm Typical
E	N/A	N/A	N/A	N/A	N/A	N/A

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Specifications	ONYX-6	ONYX-6 Direct	ONYX-8 Direct	ONYX-12 Direct	ONYX-16 Direct	LINEAR+
Maximum Sputtering Power DC	3 kW	7 kW (3 kW Indirect)	12 kW (5 kW Indirect)	30 kW (11 kW Indirect)	50 kW (20 kW Indirect)	To 250 W/Sq. Inch Direct Cooled (100W/Sq. Inch Indirect)
Maximum Sputtering Power RF	1 kW	2.5 kW (1 kW Indirect)	4 kW (1.6 kW Indirect)	10 kW (4 kW Indirect)	16 kW (7 kW Indirect)	To 100 W/Sq. Inch Direct Cooled (20W/Sq. Inch Indirect)
Cathode Voltage	100 to 1500 volts	100 to 1500 volts	100 to 1500 volts	100 to 1500 volts	100 to 1500 volts	100 to 1500 volts
Discharge Current	0.1 to 5 amps	0.1 to 12 amps	0.1 to 20 amps	0.1 to 50 amps	0.1 to 80 amps	0.4 amps/Sq. Inch
Operating Pressure	0.5 to 50 milliTorr	0.5 to 50 milliTorr	0.5 to 50 milliTorr	0.5 to 50 milliTorr	0.5 to 50 milliTorr	0.5 to 50 milliTorr
Cooling Requirements						
Flow Rate @ Max. Power	1.5 GPM	3 GPM	4 GPM	8 GPM	13 GPM	1 GPM/4KW
Maximum Input Temperature	20℃	20℃	20℃	20℃	20℃	20℃
Max. Input Pressure [open drain]	60psig	60psig	60psig	60psig	60psig	60psig
Target						
Form	Circular/ Planar	Circular/ Planar	Circular/ Planar	Circular/Planar	Circular/Planar	Rectangular/Planar
Diameter	6.0"/152.4mm	6.0"/152.4mm	8.0"/203.2mm	12.0"/304.8mm	15.0"/381 mm	Standard widths 1.5"

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						to 12", Length. To 240"
Thickness	0.010" - 0.500" (0.254mm - 12.7mm)	0.250" - 0.500" (6.35mm - 12.7mm)	0.250" - 0.500" (3.175mm - 12.7mm)	0.250" - 0.500" (6.35mm - 12.7mm)	0.250" - 0.500" (6.35mm - 12.7mm)	Typical .250"/6mm, to 1.0"/25.4mm
Cooling	Indirect	Direct/Indirect	Direct/Indirect	Direct/Indirect	Direct/Indirect	Direct/Indirect
Magnetic Enhancement	Profiled NdFeB	Profiled NdFeB	Profiled NdFeB	Profiled NdFeB	Profiled NdFeB	Profiled NdFeB
Weight (Approx; w/o options)	22 Pounds	40 Pounds	60 Pounds	120 Pounds	220 Pounds	Size Specific
Mounting						
Source	1.0" OD Tubing	1.0" OD Tubing	1.5" OD Tubing	2.0" OD Tubing	2.0" OD Tubing	Customer Specified
Water	0.375" OD Tubing	0.375" OD Tubing	0.375" OD Tubing	0.500" OD Tubing	0.500" OD Tubing	Customer Specified
Power Connector, DC	Type HN, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads	Process/System Specific	Customer Specified
Power Connector, RF	Type HN, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads	Type HN, Ext. Threads	Process/System Specific	Customer Specified
Power Cable, DC	RG 393	RG 393	RG 393	RG 393	Process/System Specific	Customer Specified
Power Cable, RF	RG 393	RG 393	RG 393	RG 393	Process/System Specific	Customer Specified
Maximum Temperature	100℃	100℃	100℃	100℃	100℃	100℃
Source of Substance Distance	2 - 12"	2 - 12"	2 - 12"	2 - 12"	2 - 12"	2 - 12"
Construction						

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Cathode Body	OFHC Copper	OFHC Copper	OFHC Copper	OFHC Copper	OFHC Copper	OFHC Copper
Anode	304/316 Stainless Steel	304/316 Stainless Steel	304/316 Stainless Steel	304/316 Stainless Steel	304/316 Stainless Steel	304/316 Stainless Steel
Insulator	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE
Dimensions						
A	7.13"/181.0mm	8.45"/214.6mm	10.06"/255.4mm	14.5"/368.3mm	18.5"/470 mm	IM.Length +2.0"/50.8 mm EM. Length +3.5"/88.9 mm
B	5.0"/127.0mm	5.17"/131.3mm	6.32"/160.5mm	4.0"/101.6 mm	4.0"/101.6 mm	IM. Width +2.0"/50.8 mm EM.Width +3.5"/88.9 mm
C	1.38"/34.9mm	1.38"/34.9mm	2.38"/603.3mm	2.500"/63.5mm	2.500"/63.5mm	IM. 3.5" Typical EM. 3.5" Typical
D	1.0"/25.4 mm Typical	1.0"/25.4 mm Typical	1.5"/38.1 mm Typical	2.0"/50.8mm Typical	2.0"/50.8mm Typical	IM. N/A EM. Width +2.0"/50.8 mm
E	N/A	N/A	N/A	N/A	N/A	IM. N/A EM. Lenth +2.0"/50.8 mm

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High Purity Target and PVD Materials

A Materials	Symbol
Aluminum	Al
Aluminum Copper	AlCu
Aluminum Copper Tungsten	AlCuW
Aluminum Nitride	AlN
Aluminum Oxide	Al203
Aluminum Silicon	AlSi 1% AlSi 2%
Aluminum Silicon Copper	AlSiCu
Antimony	Antimony
Antimony Oxide	Sb203
B Materials	**Symbol**
Barium	Ba
Barium Ferrite	BaFe12O19
Barium Fluoride	BaF2
Barium Oxide	BaO
Barium Strontium Titanate	Ba0.5Sr0.5TiO3
Barium Titanate	BaTiO3
Beryllium	Be
Bismuth	Bi
Bismuth Lanthanum Titanium Oxide	BiLaTiO3
Bismuth Oxide	Bi2O3
Bismuth Titanium Oxide	Bi4Ti3 Oxide
Boron	B
Boron Carbide	B4C
Boron Nitride	BN
C Materials	**Symbol**
Cadmium Oxide	CdO
Cadmium Selenide	CdSe
Cadmium Sulfide	CdS
Cadmium Telluride	CdTe
Calcium Fluoride	CaF2
Calcium Oxide	CaO
Calcium Silicate	CaSiO3 CaO - SiO2
Calcium Titanate	CaTiO3
Carbon (Graphite)	C
Carbon Steel	
Cerium	Ce
Cerium Oxide	Ce2O3
Chromium	Cr
Chromium Boride	CrB2
Chromium Oxide	Cr2O3
Chromium Silicide	CrSi2
Cobalt	Co
Cobalt Chromium	CoCr
Cobalt Iron	CoFe
Cobalt Iron Boron	CoFeB

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Cobalt Oxide	CoO
Cobalt Silicide	CoSi2
Cobalt Zirconium	CoZr
Copper	Cu
Copper Gallium	CuGA
Copper Indium	CuIn
Copper Indium Gallium Selenide	CuInGaSe
Copper Indium Selenide	CuInSe2
Copper Oxide	CuO
Copper Sulfide	Cu2S
D Materials	Symbol
Dysprosium	Dy
E Materials	Symbol
Erbium	Er
Erbium Oxide	Er2O3
Europium	Eu
G Materials	Symbol
Gadolinium	Gd
Gadolinium Oxide	Gd2O3
Gallium	Ga
Gallium Arsenide	GaAs
Gallium Oxide	Ga2O3
Germanium	Ge
Germanium Nitride	Ge3N4
Germanium Oxide	GeO2
Gold	Au
Gold Germanium	Au / Ge (88/12)
Gold Palladium	AuPd
Gold Tin	AuSn
Gold Zinc	Au / Zn (99/1)
H Materials	Symbol
Hafnium	Hf
Hafnium Carbide	HfC
Hafnium Nitride	HfN
Hafnium Oxide	HfO2
Holmium	Ho
I Materials	Symbol
Inconel	
Indium	In
Indium Oxide	In2O3
Indium Tin Oxide	ITO - In2O3-SnO2
Iridium	Ir
Iron	Fe
Iron Oxide	Fe2O3
L Materials	Symbol
Lanthanum	La
Lanthanum Aluminate	LaAlO3
Lanthanum Boride	LaB6
Lanthanum Oxide	La2O3
Lanthanum Strontium Cobalt Oxide	LaSrCoO3
Lanthanum Strontium Manganese Oxide	La0.8Sr0.2Mn Oxide

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Lead	Pb
Lead Oxide	PbO
Lead Titanate	PbTiO3
Lead Zirconium Titanate Oxide	PbZrTi Oxide
Lithium	Li
Lithium Carbonate	Li2CO3
Lithium Cobalt Oxide	LiCoO2
Lithium Niobate	LiNbO3
Lithium Phosphate	Li3PO4
Lithium Tantalate	LiTaO3
M Materials	Symbol
Magnesium	Mg
Magnesium Fluoride	MgF2
Magnesium Oxide	MgO
Manganese	Mn
Molybdenum	Mo
Molybdenum Oxide	MoO3
Molybdenum Selenide	MoSe2
Molybdenum Silicide	MoSi2
Molybdenum Sulfide	MoS2
N Materials	Symbol
Neodymium	Nd
Neodymium Gallium Oxide	NdGaO3
Neodymium Iron Boride	NdFeB
Nickel	Ni
Nickel Chromium	NiCr
Nickel Cobalt	NiCo
Nickel Oxide	NiO
Nickel Silicide	Ni2Si
Nickel Vanadium	NiV
Niobium	Nb
Niobium Oxide	Nb2O5
P Materials	Symbol
Palladium	Pd
Platinum	Pt
Praseodymium	Pr
R Materials	Symbol
Rhenium	Re
Rhodium	Rh
Ruthenium	Ru
S Materials	Symbol
Samarium	Sm
Samarium Cobalt	SmCo
Scandium	Sc
Scandium Oxide	Sc2O3
Selenium	Se
Silicon	Si
Silicon Carbide	SiC
Silicon Dioxide	SiO2
Silicon Monoxide	SiO
Silicon Nitride	Si3N4

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Silver	Ag
Silver Oxide	Ag2O
Strontium Titanate	SrTiO3
T Materials	Symbol
Tantalum	Ta
Tantalum Carbide	TaC
Tantalum Nitride	TaN
Tantalum Oxide	Ta2O5
Tantalum Silicide	TaSi2
Tellurium	Te
Terbium	Tb
Terbium Iron	TbFe
Tin	Sn
Tin Oxide	SnO
Titanium	Ti
Titanium Boride	TiB2
Titanium Carbide	TiC
Titanium Nitride	TiN
Titanium Oxide	TiO2
Titanium Silicide	TiSi2
Tungsten	W
Tungsten Silicide	WSi2
Tungsten Sulfide	WS2
Tungsten Titanium	WTi
V Materials	Symbol
Vanadium	V
Vanadium Oxide	V2O5
Y Materials	Symbol
Yttrium	Y
Yttrium Barium Copper Oxide	YBa2Cu3Ox
Yttrium Oxide	Y2O3
Z Materials	Symbol
Zinc	Zn
Zinc Aluminum	ZnAl
Zinc Oxide	ZnO
Zinc Oxide / Aluminum Oxide	ZnO / Al2O3
Zinc Oxide / Gallium Oxide	ZnO / Ga2O3
Zinc Oxide / Magnesium Oxide	ZnO / MgO
Zinc Selenide	ZnSe
Zinc Sulfide	ZnS
Zinc Telluride	ZnTe
Zirconium	Zr
Zirconium Carbide	ZrC
Zirconium Nitride	ZrN
Zirconium Oxide	ZrO2
Zirconium Oxide Yttrium Oxide	ZrO2-Y2O3
Zirconium Silicate	ZrSiO4

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Sputtering Yields

Target Material	Density (g/cc)	Yield @ 600 ev	Rate* (Å/sec)
Ag	10.5	3.4	380
Al	2.7	1.2	170
Al98Cu2	2.82		170
Al2O3	3.96		40
Al99Si1	2.66		160
Au	19.31	2.8	320
Be	1.85	0.8	100
B4C	2.52		20
BN	2.25		20
C	2.25	0.2	20
Co	8.9	1.4	190
Cr	7.2	1.3	180
Cu	8.92	2.3	320
Fe	7.86	1.3	180
Ge	5.35	1.2	160
Hf	13.31	0.8	110
In	7.3		800
In2O3	7.18		20
ITO	7.1		20
Ir	22.42	1.2	135
Mg	1.74	1.4	200
MgO	3.58		20
Mn	7.2	1.3	180
Mo	10.2	0.9	120
MoS2	4.8		40
MoSi2	6.31		110
Nb	8.57	0.6	80
Ni	8.9	1.5	190
Ni81Fe19	8.8		110
Ni80Cr20	8.5		140
Ni93V7	8.6		100
Os	22.48	0.9	120
Pd	12.02	2.4	270
Pt	21.45	1.6	205
Re	20.53	0.9	120
Rh	12.4	1.5	190
Ru	12.3	1.3	180
Si	2.33	0.5	80
SiC	3.22		50
SiO2	2.63		70
Si3N4	3.44		40
Sn	5.75		800
SnO	6.45		20
Ta	16.6	0.6	85
TaN	16.3		40

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Ta2O5	8.2		40
Th	11.7	0.7	85
Ti	4.5	0.6	80
TiN	5.22		40
TiO2	4.26		40
U	19.05	1	155
V	5.96	0.7	85
W	19.35	0.6	80
W90Ti10	14.6		80
WC	15.63		50
Y	4.47	0.6	85
YBCO	5.41		10
Zn	7.14		340
ZnO	5.61		40
ZnS	3.98		10
Zr	6.49	0.7	85
ZrO2	5.6		40

Power & Cooling

Power and cooling requirements are critical considerations in magnetron operation, and the two are inextricably intertwined.

The power level directly affects the deposition rate. But approximately 80% of the power in the plasma is converted to heat, which must be removed by the water-cooling system. Otherwise, it may damage the target, the magnets, and perhaps the substrate as well.

We provide two types of magnetron cooling designs:

■Direct Cooling

In this approach, the cooling water is brought into direct contact with the target (if it is a metal), or with the target's backing plate (when an insulator or a "tiled" target must be bonded to one). This is the most efficient method of cooling, but it demands that target changes be done very carefully, to avoid allowing excess water into the chamber.

■Indirect Cooling

In this approach, the cooling water is not brought into direct contact with the target itself, but with the cathode body, to which it is clamped. Cooling is thereby achieved via conduction through the cathode body. Because this is less efficient than direct cooling, an indirectly cooled

magnetron has a lower maximum power limit, and hence a lower maximum sputtering rate.

The following table is a useful guide to maximum power limits, and selection of the appropriate power supply. Note that the power limit for indirectly cooled magnetrons can be increased by about 15% by using a thermally conductive paste to enhance heat transfer.

	Max. DC Power (watts/ in2)	Max. DC Power (watts/ cm2)
Direct	250	39
Indirect	100	16

- Pulsed or Medium Frequency -MF- maximum power is the same as the DC level.
- Maximum RF power is 1/3 the values in the above table.

Cooling Requirements

We strongly suggest that the magnetron power supply be interlocked with a water flow switch. That way, power cannot be applied to a magnetron unless water is flowing. The water should be supplied at or slightly below room temperature, and the flow rate should be 1gal/min (4L/min) for every 4 Kilowatts of applied DC power. The inlet pressure should be maintained at less than 60 psi (4 bar), to prevent leakage or distortion of the cathode body. Outlet pressure should be 0 psi or into an open drain. Operation manual will have actual specifications.

Water Flow:	1 Gallon per minute (3.78 Liter per minute)/4 kW Power
Water Temperature:	65 °F (18 °C) inlet recommended. Range 55 - 75 °F <(13 - 24 °C)> Rise in outlet should not exceed 10 °F (6 °C) Inlet temperature should remain above local dew point to prevent condensation on target surface
pH Level:	Range 6 to 8
Water Pressure:	Unless otherwise specified, 60 PSI (4 bar) maximum inlet 0 PSI maximum outlet, open to drain
Resistivity: Conductivity:	Greater than 100k Ohms (relative to ground) Less than 10 microSiemens
Particulate:	Water should be filtered to less than 100 microns, especially for magnetic particles, which can build up on magnets and impede cooling water flow

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The chart below represents the maximum flow rate possible when using that sized tubing on a magnetron. For example this means that the max flow rate through any cathode with ¼" convoluted tubing will be no more than 1 gallon/minute. All of these tests were done with a water inlet pressure of 60 psig and an outlet to atmospheric drain.

Straight Wall	GPM	Convoluted	GPM
3/16" O.D. x .040 Wall	0.75	-	-
1/4" O.D. x .040 Wall	1.25	1/4" O.D. x .030 Wall	1
3/8" O.D. x .060 Wall	3	3/8" O.D. x .030 Wall	2.8
1/2" O.D. x .060 Wall	6.4	1/2" O.D. x .030 Wall	5.7

Company Information

北京时代天启真空科技有限公司

Beijing Timestorch Vacuum Technology Co., Ltd.

联系人：【张照薪】

电　话：【15010907160】

传　真：【010-52818165】

邮　箱：【alexzhang@timestorch.com.cn】

地　址：【北京市朝阳区天朗园 C 座 3 层丰收孵化器园】

网　站：【www.timestorch.com.cn】

天启国际科技（香港）有限公司

Torch International Tech. Co., Limited

地　址：【香港湾仔骆克道 53-55 号恒泽商业大厦 15 楼 1501 室】