MAK™

OWNER'S OPERATION
AND
MAINTENANCE MANUAL
OF THE
MAK™ SPUTTERING SOURCES

Manufactured by:

6280 San Ignacio Avenue, Suite E
San Jose, CA 95119-1365
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YOUR S/N _____

WARNING

AS WITH ALL ELECTRICAL DEVICES, THERE IS A SHOCK HAZARD ASSOCIATED WITH THIS DEVICE. ALL INSTRUCTIONS SHOULD BE FOLLOWED PERTAINING TO THE USE OF SUITABLE INTERLOCKS ON ALL POWER SUPPLIES TO BE USED TO POWER THIS PRODUCT.

MAK SOURCE MANUAL

Precautions to be taken to assure proper operation of your MAK

• Water MUST be flowing thru the MAK while sputtering. Please see O&M manual for flow requirements.

If MAK has been operated without water --- DO NOT turn the water on --- allow the MAK to cool down before turning water on.

• Target paste [supplied with MAK] must be used. This provides a thermal layer between the target and cathode [Copper block]. It is required to protect against uneven or irregular surfaces of the target and / or cathode.

Failure to use target paste can damage the MAK. A VERY SMALL AMOUNT SHOULD BE APPLIED -- A GLOVED FINGER USED TO SPREAD EVENLY OVER THE CATHODE BLOCK. The block should be clearly visible --- thru a thin gray film.

NOTE: A substitute paste such as thin [0.005"] Indium foil can also be used.

• A keeper **MUST** be used for all targets --- including magnetic. The keeper is used for centering of the target and maintaining a continuous magnetic path.

• Ceramic or Oxide targets --- **MUST** --- be bonded to a copper backing plate that contains a keeper.

• MAK Sputter Source should be **CLEANED** on a routine basis. This is easily accomplished during target change.

1. With target removed, clean entire cathode assembly --- removing any foreign material present. Cleaning of both inside and outside of the block is suggested.
2. Clean the anode shield.

NORTHERN CALIFORNIA
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TARGET SUPPLIERS

1) ACI Alloys
1985 Las Plumas Avenue
San Jose, CA 95133
Mr. Larry Albert
PH: (408) 259-7337
FX: (408) 729-0277

2) Cerac, Inc.
Box 1178
Milwaukee, WI 53201
Mr. Rick Vehlow x255
PH: (414) 289-9800
FX: (414) 289-9805

3) Plasmaterials
2268 Research Drive
Livermore, CA 94550
Shawna Kent, Don Sarrach,
Frank Manarello
PH: (925) 447-4030 x13
FX: (925) 447-4031

4) Praxair
16130 Wood Red Road #7
Woodinville, WA 98072
Mr. Ron Ekdahl
PH: (425) 487-1769
FX: (425) 487-1859

5) Pure Tech, Inc.
42 Mt. Ebo Road South
Brewster, NY 10509
PH: (845) 279-0900
FX: (845) 279-0922

6) Target Materials
1145 Chesapeake Avenue
Columbus, Ohio 43212
PH: (614) 486-7055
FX: (614) 486-0912

7) Tico Titanium
52900 Grand river
New Hudson, MI 48165
Mr. J.P. Cruzen
PH: (248) 446-0400
FX: (248) 446-1995

8) Vacuum Engineering & Materials Co.
807 Aldo Ave., #106
Santa Clara, CA 95056
Jack Kavanaugh, Gina Craig
PH: (408) 986-8900
FX: (408) 986-8980

INTRODUCING US, INCORPORATED

US, Incorporated has been an innovative manufacturer and sales organization of thin film and high vacuum equipment since 1977. Exclusive licenses were obtained from Stanford University and Lawrence Livermore Laboratory to build and distribute their patented magnetron sputtering sources on a worldwide basis.

US INCORPORATED QUALITY ASSURANCE

All US, Incorporated products are manufactured under the most stringent conditions. This includes proper selection & inspection of original materials, assembly in clean room conditions, and complete testing for leaks & functionality. These quality products are packaged in durable containers for shipment throughout the world.

INTRODUCING MAK SPUTTER SOURCES

The US, Incorporated MAK sputter sources were designed, developed & tested under controlled laboratory conditions at a major United States government laboratory. This low cost planar magnetron sputtering source is compact, easy to install and requires no target bonding. All of the US, Incorporated MAK sputter sources (1.3, 2, and 3, 4 and 6 inch) provide shielded electrical paths which allow **RF as well as DC power** to the cathode with minimum line losses and low reflection of RF power.

The MAK sputter source has a unique feature of allowing low operational pressures (0.5 millitorr) as well as high operational pressures (600 millitorr) without losing the focused plasma to the target. **The MAK sputter source is available in non-UHV and UHV designs.**

WHAT IS MAGNETRON SPUTTERING?

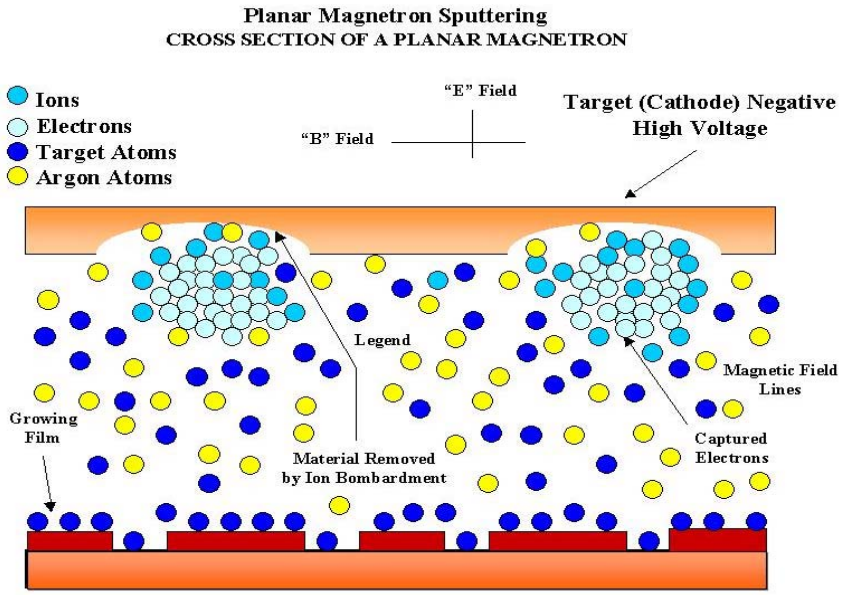
Observations of the phenomenon we now call sputtering, go back over one hundred years to early experiments which introduced electricity into a reduced pressure atmosphere. L. Holland describes these beginnings in his book Vacuum Deposition of Thin Films.

"When an electrical discharge is passed between electrodes at a low gas pressure, the cathode electrode is slowly disintegrated under the bombardment of the ionized gas molecules. This phenomenon is termed cathodic sputtering. The disintegrated material leaves the electrode surface either as free atoms or in chemical combination with the residual gas molecules. Some of the liberated atoms are condensed on surfaces surrounding the cathode while the remainder are returned to the cathode by collision with gas molecules."

The ensuing process might be compared to a fine sand blasting in which the momentum of the bombarding particles is more important than their energy. The inert gas argon was chosen, to act as the sputtering medium, because it is a heavy rare gas and is plentiful. It also has a low ionization potential. The inert nature of argon inhibits compounds from being formed at the target surface.

Once sputtered, the target atoms travel until they reach a nearby surface most notably, the substrate. The deposited layer forms or grows on the substrate structure, influenced by such things as material, temperature and gas structure.

When the ions strike the target, their primary electrical charge is neutralized (gain back the lost electron) and they return to the process as atoms. Thus, direct current sources generally prevail as the electrical energy source.



In order to increase sputtering rate, magnetic coils were sometimes placed around the chamber to pinch the plasma during the deposition. The pressure was reduced to 20 microns (2 X 10^{-2} torr) and the rates increased. The electrodes were close together and the R.F. voltage was high. These conditions caused damage to semiconductor devices due to the high electron and secondary ion bombardment, which took place.

When it was realized how important the role of a magnetic field was in concentrating the plasma and the effects that it had on rate, sputtering became more attractive as a commercial process. Several magnetic configurations were used such as the post cathode, magnetically enhanced hollow cathodes and magnetrons. In order to make a magnetron work, it is necessary to cause the E X B drift currents to close on themselves. This realization led to the magnetron cathode designs that are in use today.

MAK BENEFITS

BENEFITS OF THE MAK

SIMPLICITY IN SPUTTERING

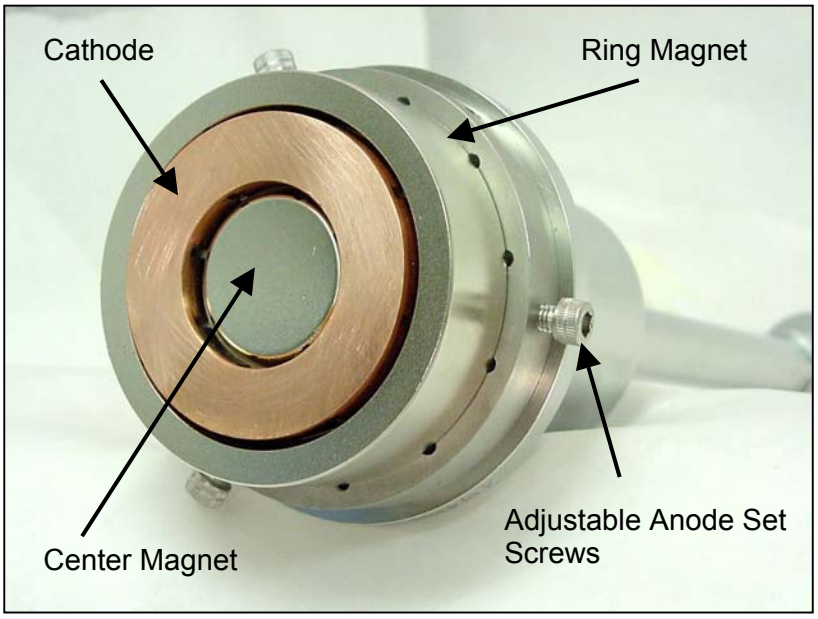
Magnetics

Balanced / Unbalanced

- Magnet array is INTERCHANGEABLE from balanced or unbalanced. Disassembly of source NOT REQUIRED!

No Magnetic Housing

- Provides higher magnetic density at target surface
- Sputters at lower voltage for comparable power levels
- Standard MAK sputters magnetic material



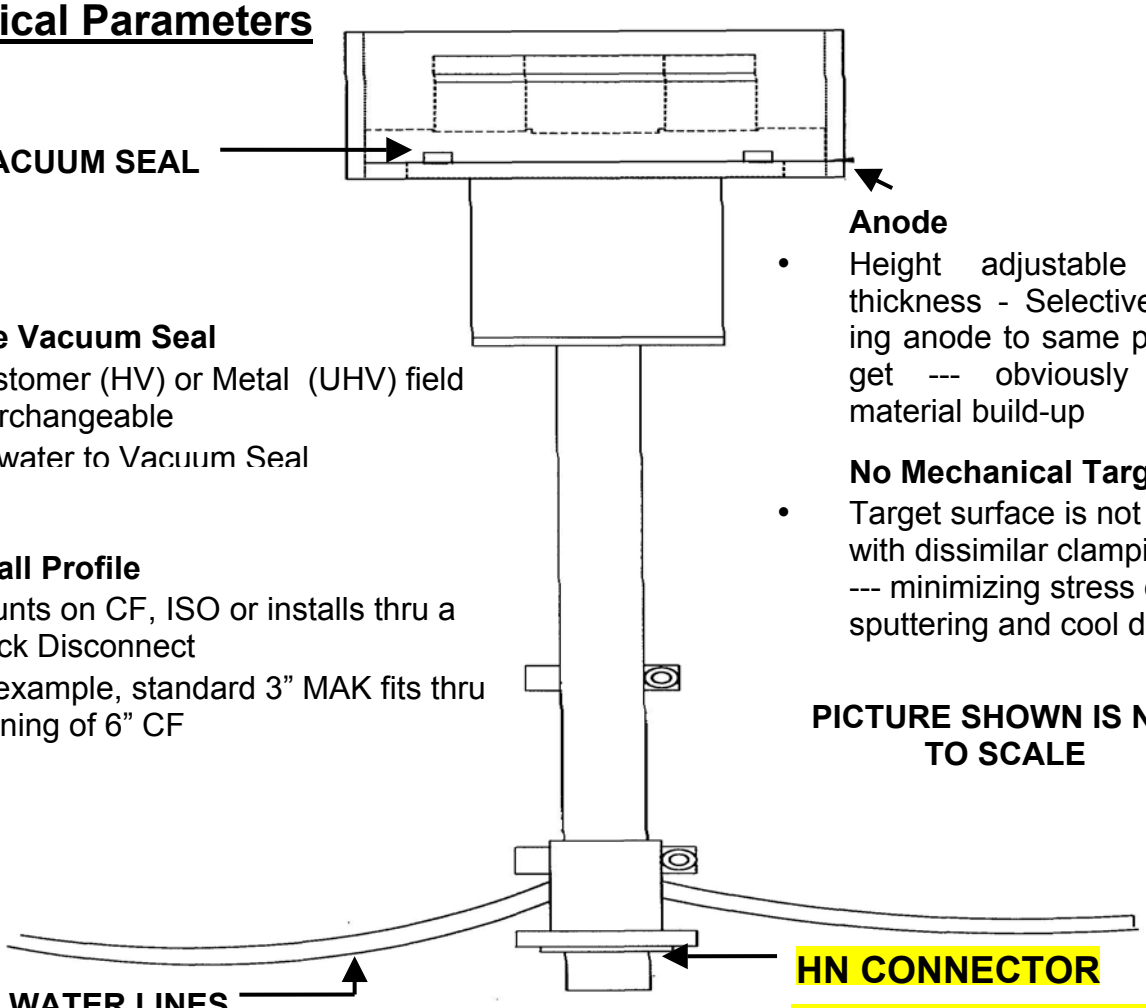
RF SPUTTERING

If the target is an insulator, the neutralization process results in a positive charge on the target surface. This charge may grow to the point that the bombarding ions (±) are repelled and the sputtering process will stop. In order to make the process continue the polarity of the target must be reversed to attract enough electrons from the discharge to eliminate the surface charge. In order to attract the electrons and not repeal the ions, the frequency must be high enough to reverse before the direction of the ions are affected. The usual industrial frequency assigned by the FCC for such is in the MHz range. Since this is a "radio" frequency, the process is called radio frequency sputtering, or RF sputtering. Most of the early sputtering was done using direct current sources. This meant high voltage, with current drawn being limited by the gas pressure. Typical voltages were 3-5 kV with a current from 50-250 ma at pressures of 50-250 microns. R.F. power was introduced because it makes it possible to sputter insulators.

BENEFITS OF THE MAK

SIMPLICITY IN SPUTTERING

Physical Parameters



One Vacuum Seal

- Elastomer (HV) or Metal (UHV) field interchangeable
- No water to Vacuum Seal

Small Profile

- Mounts on CF, ISO or installs thru a Quick Disconnect
- As example, standard 3" MAK fits thru opening of 6" CF

Anode

- Height adjustable to target thickness - Selectively positioning anode to same plane as target --- obviously minimizing material build-up

No Mechanical Target Clamp

- Target surface is not in contact with dissimilar clamping material --- minimizing stress during sputtering and cool down

PICTURE SHOWN IS NOT TO SCALE

- Teflon water lines with quick disconnects

- Standard HN power connector permits RF/DC operation

OPERATION OF THE MAK

VACUUM SYSTEMS

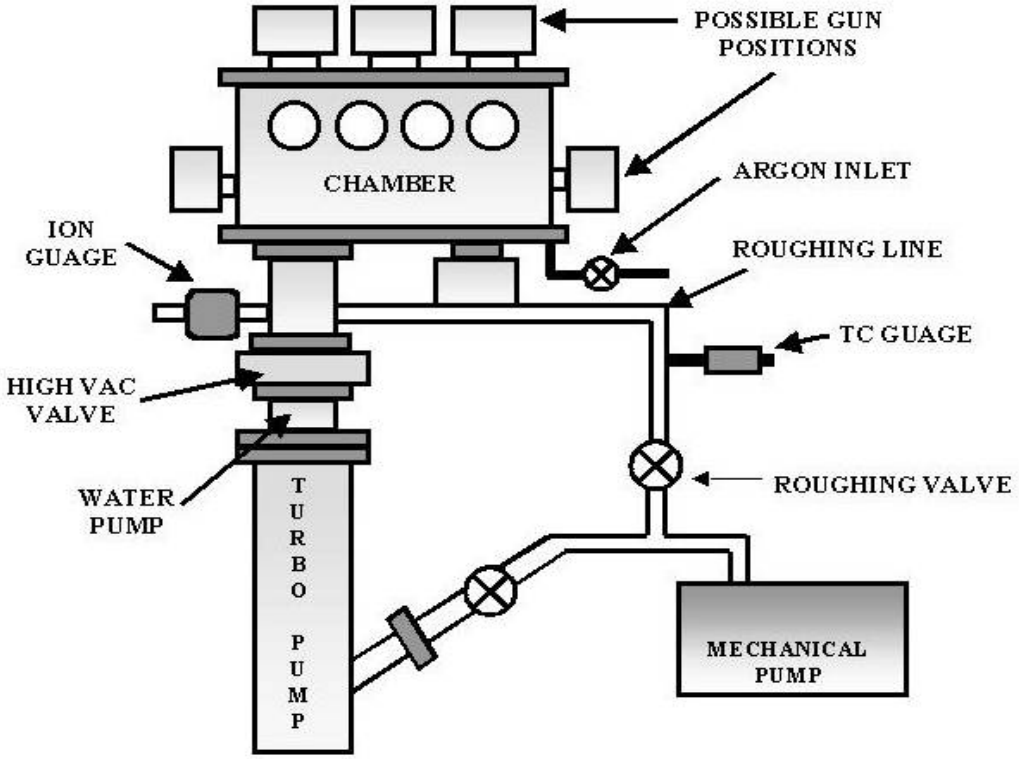
To successfully operate the Mighty MAK Series, a leak-tight vacuum system must be available. This system should be pumped with a high vacuum pump of the turbo, or a cryo type. It may be necessary to have a throttle valve, or orifice in the system to control pump throughput while the sputtering gas is introduced. If a cryopump is used, the throttle valve may not be required, however, it is desirable if sputtering gas pressures of more than five microns are to be used.

The vacuum system should be equipped with suitable gauging to measure and monitor pressures in the 0.5-600 micron range during sputtering, and the $1x10^{-5}$ to $1x10^{-9}$ torr range during pre-sputter pump down. The system must also be equipped with a fine metering valve and separate in-series shut-off valve used for the introduction of the sputtering gas.

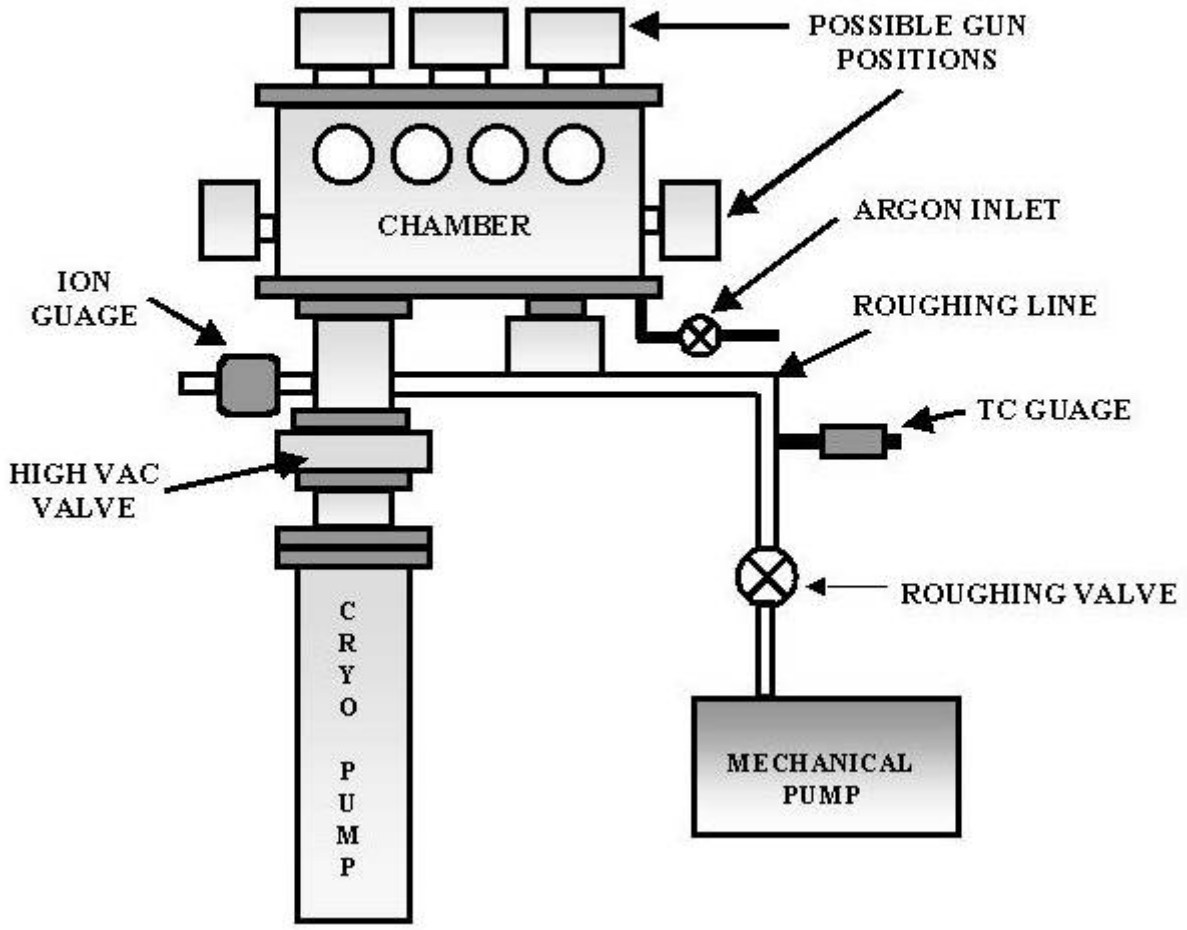
A suitable fixture for mounting and holding the substrate(s) during film deposition should be provided, in conjunction with a means of shuttering the source (target) from the substrate during pre-cleaning of the target.

Since the Mighty MAK Series will not operate properly if the shutter is positioned too close to the target, it is suggested that the total distance from target to substrate be at least 1".

TURBO PUMPED SYSTEM



CRYO - PUMPED SYSTEM



To obtain ideal uniformity, the distance from source to substrate should be adjustable.

Note: The rate will decrease by the square of the distance between source to substrate, however uniformity will be enhanced as this distance is increased.

The chamber may be made of glass or metal. If the chamber is metal, a viewing port should be provided for observation during sputtering.

MAK TECHNICAL SPECIFICATIONS

MAK SIZE:		MAK 1.3" (33mm)	MAK 2" (50.8mm)	MAK 3" (76.2mm)	MAK 4" (101.6mm)	MAK 6" (152.4mm)
TARGET						
Target Thickness min-max	mm inch	1.00-5.70 0.040-0.225	1.00-9.50 0.040-0.375	1.00-15.90 0.040-0.625	1.00-19.05 0.040-0.750	2.00-25.40 0.080-1.000
Magnet Target- (1) Thickness min-max	mm inch	1.00-2.54 0.040-0.100	1.00-4.70 0.040-0.187	1.00-6.35 0.404-0.250	1.00-9.50 0.404-0.375	2.00-11.00 0.080-0.437
Target Volume max	ccm cu inch	4.90 0.30	19.25 1.17	72.47 4.42	154.00 9.40	463.00 28.25
Target Suface Area	cm. sq. sq in	8.56 1.33	20.27 3.14	45.60 7.07	81.10 12.56	182.4 28.25
ELECTRICAL						
Max Power Dc	watts	350.00	1000.00	2000.00	3000.00	6000.00
Max Power RF	watts	200.00	400.00	750.00	1200.00	2000.00
Max Power DC (Per)	cm sq in sq	40.88 263.00	49.30 318.00	43.86 283.00	37.00 240.00	33.00 212.00
Max Power RF (Per)	cm sq in sq	24.00 150.00	20.00 130.00	17.00 106.00	15.00 96.00	11.00 70.00
Max Current	amps	1.00	3.00	5.00	7.00	10.00
VOLTAGE Min-Max		200-1000	200-1000	200-1000	200-1000	200-1000

MAK TECHNICAL SPECIFICATIONS

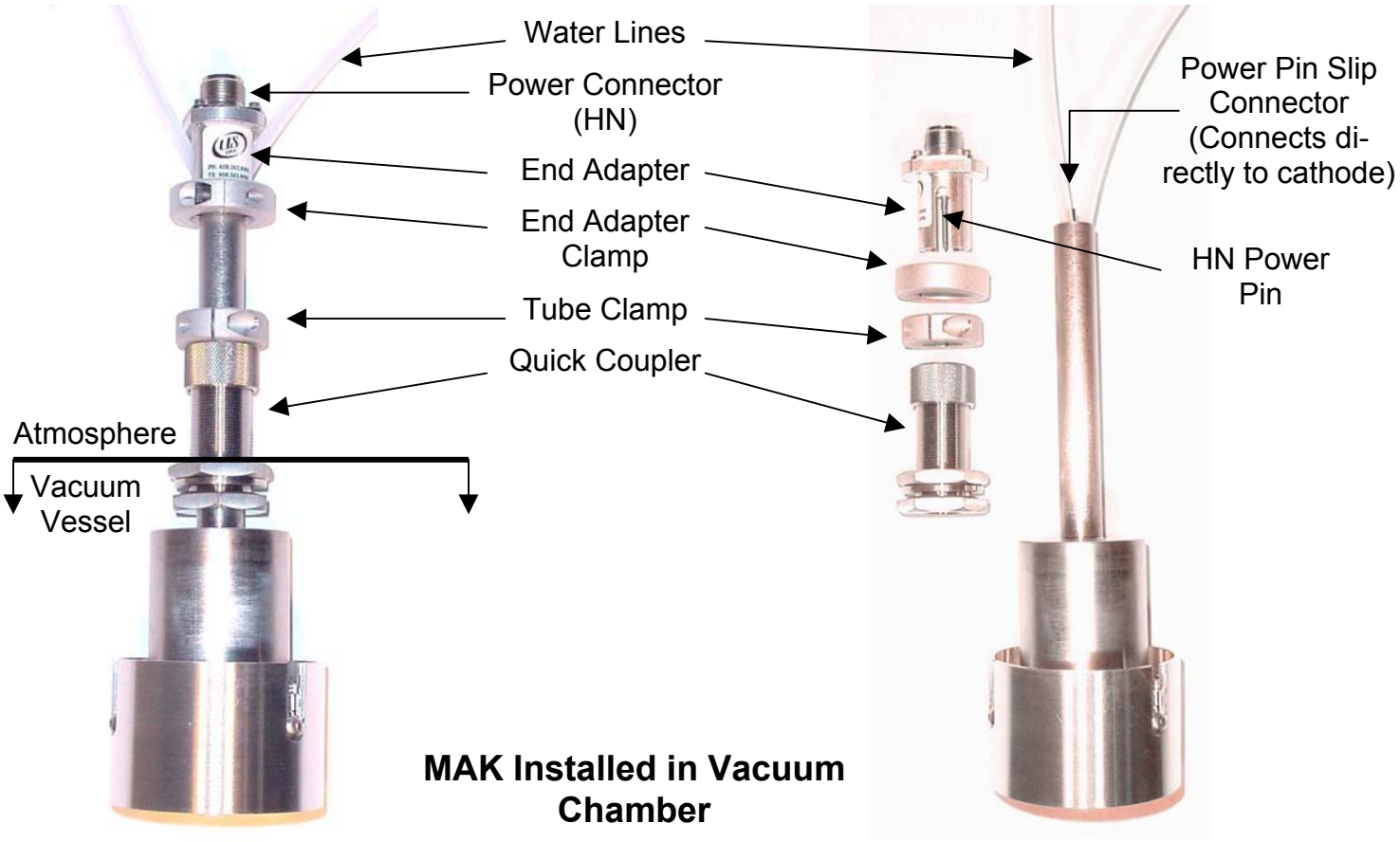
COOLING		**MAK 1.3" (33mm)**	**MAK 2" (50.8mm)**	**MAK 3" (76.2mm)**	**MAK 4" (101.6mm)**	**MAK 6" (152.4mm)**
Water Flow at 30psi min. at lowest power level	l/min gal/min	3.48 0.90	3.48 0.90	3.48 0.90	3.48 0.90	7.00 1.840
Nominal Water Flow at 60psi for max. power	1/min gal/min	6.20 1.60	6.20 1.60	6.20 1.60	6.20 1.60	12.40 3.20
Water Pressure Range	Bar psi	2.1-5.6 30-80	2.1-5.6 30-80	2.1-5.6 30-80	2.1-5.6 30-80	2.1-5.6 30-80
Water Lines Size		1/4" OD 3/16" ID	1/4" OD 3/16" ID	1/4" OD 3/16" ID	1/4" OD 3/16" ID	3/8" OD 1/4" ID
MECHANICAL						
Max OD	mm inch	59.70 2.350	59.70 2.350	85.80 3.378	104.80 4.125	170.80 6.725
Smallest Mounting Flange	CF ISO	4-1/2"[DN63] NW 63	4-1/2"[DN 63] NW 63	6"[DN 100] NW 100	6-3/4"[DN125] NW 160	10"[DN200] NW 200
Shaft Diameter	mm inch	19.05 0.75	19.05 0.75	19.05 0.75	19.05 0.75	31.75 1.25
Anode Adjustable To Target Thick-ness		NO	YES	YES	YES	YES
Weight	lbs. kgms.	1.75 3.85	2.0 4.4	4.0 8.8	5.5 12.1	13.0 28.6
PERFORMANCE						
Rate For Cu @ 5 mtorr Ar. Target To Substrate = Diameter Of MAK[2]	Angstrom / Sec	35@200W	100@500W	165@1.5KW	160@2.5KW	145@5KW
UNIFORMITY Substrate Dia. = Source dia. Target to Sub-strate = Dia. of Source[2]	± %	5%	6%	8%	8%	7%

(1) Maximum magnetic target thickness is material dependent.
(2) Means 2" MAK @ 2" target to substrate 4" MAK @ 4"

INSTRUCTIONS ON INSTALLATION OF SOURCES

STANDARD MOUNTING

To mount the source a **QUICK COUPLE** feedthrough adapter is required. A 0.75” adapter is used for the 1.3”, 2”, and 3”, and 4” sources. The 6” MAK requires a 1.25” quick coupler adapter.



MAK Installed in Vacuum Chamber

A. PREPARING THE SOURCE FOR MOUNTING VIA A QUICK COUPLER

1. Loosen the Clamp End Adapter holding the electrical connector on the end of the tube.
2. Slide the clamp off the tube. Pull straight out on the electrical connector mounting assembly. The whole assembly will come off, leaving the water tubes free and the electrical connector assembly unplugged from the power feed rod.
3. Remove the clamp tube from the tube. This clamp is designed to keep the source in position when the system is under vacuum.
4. From the inside of the vacuum system, insert the water tubes into the feedthrough hole, and then insert the tube. Position the tube to the approximate desired source to substrate distance.
5. Slide on the “O” ring, compression ring and coupler nut. Hand tighten the nut.
6. Slide on the clamp tube, position and tighten.

7. Put the Clamp End Adapter on the tube and then assemble the electrical connector. Make sure that the slip pin in the connector body is inserted in the socket of the power feed rod. Push on as far as it will go and slide the Clamp end Adapter on and tighten.
8. The system may now be pumped down.
9. Hook up the water lines. Connect the house supply and drain lines to the source tubes. See technical specifications for minimum flow requirements.
10. Connect the power cable.

B. DIRECT FLANGE MOUNTING VIA CF/ISO/ANSI

1. MAK Source has been attached to the mounting flange. To adjust source to substrate distance --- either the substrate must be moved or a feedthru nipple must be placed between the mounting flange and the vacuum system.
2. Attach the MAK mounting flange to the system.
3. Refer to step (7) above.

3" MAK Welded onto Conflat Flange
PN: L300A01-CF

POWER HOOK-UP

All US Incorporated MAK sputter sources may be operated in either the DC or RF mode. All models are supplied with an HN (Amphenol UG-496/U) for convenient electrical connection to your choice of power source. The following US, Incorporated Sputtering Power Supplies come complete with output cables having the HN mating connector.

P/N SU-500 DC 500 Watt DC Power Supply
P/N SU-1500 DC 1500 Watt DC Power Supply
P/N SU-5000 DC 5000 Watt DC Power Supply
P/N SU-600RF/ SU-600 ATN 600 Watt RF Generator and Automatic Tuning Network
P/N SU-1250RF/ SU-1250ATN 1250 Watt RF Generator and Automatic Tuning Network

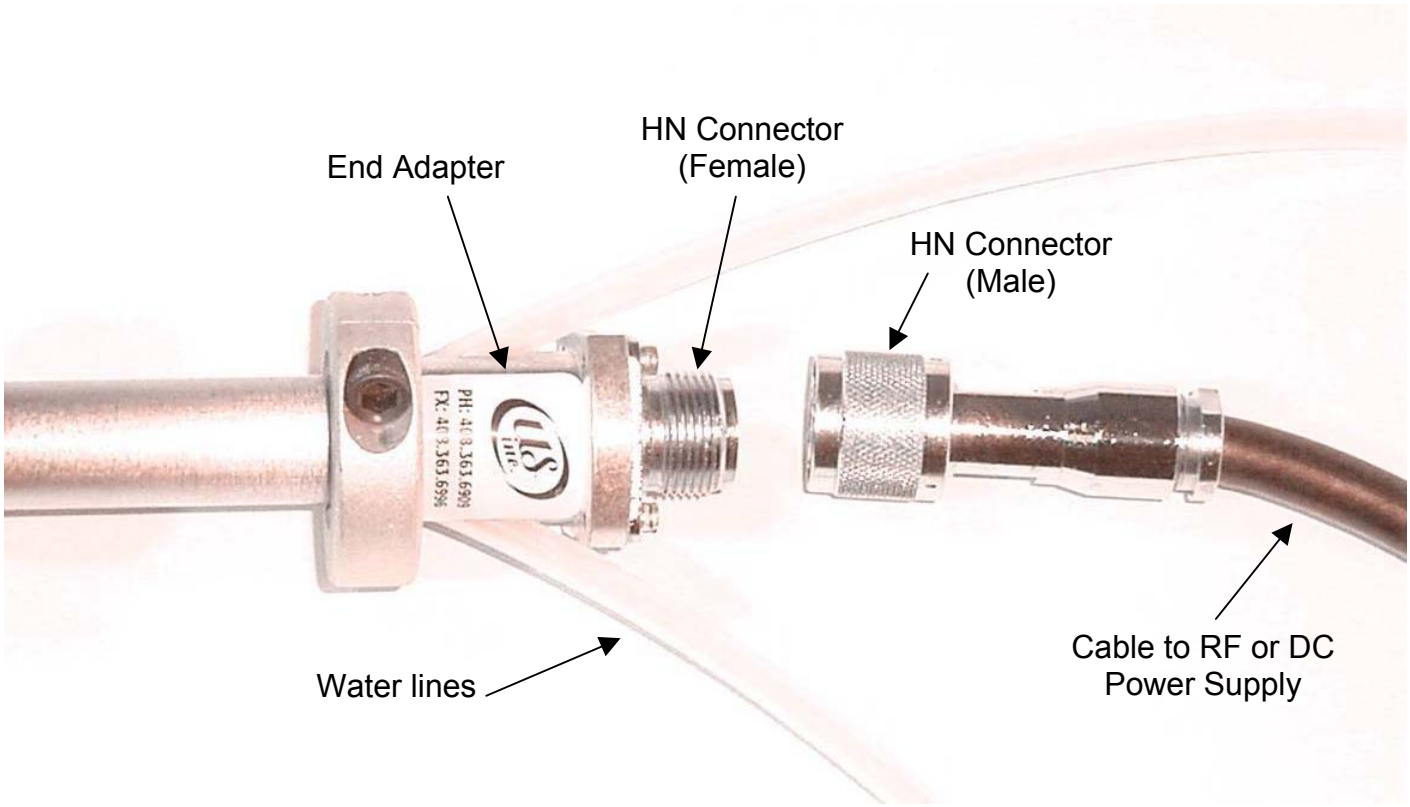
DC Connection

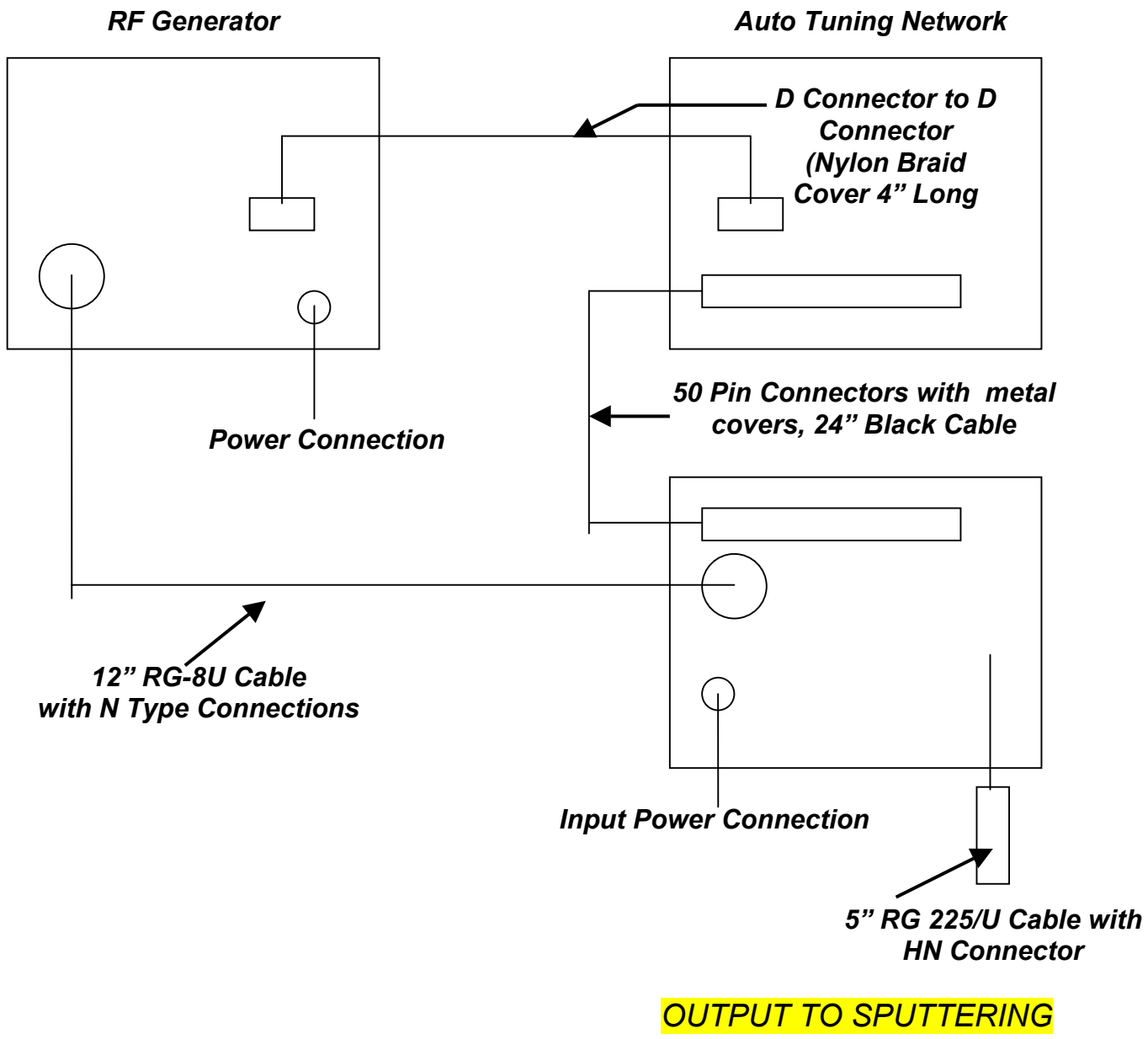
The SU-1000 DC is provided with twelve feet of RG 8/U high voltage cable. Connect the PL 259 connector to the power supply and the HN connector to the sputter source.

RF Connection

The RF Generator / Automatic Tuning Network is provided with all necessary cables for hook-up.

- Twelve-foot co-axial cable for connection of the power supply to tuning network
- Three-foot co-axial cable for connection of tuning network to sputter source (HN Connector)
- Twenty-four foot interface cable between network controller and tuning network
- Four-foot control cable between control panel and RF supply





CAUTIONS IN RF HOOK-UP

Cable length between should be a derivative of the 13.56 MHz. Wave length. Approximately 48, 24, or 12 feet and be 50 ohm RF shielded cable.

Cable length between the tuning network and sputter source should be minimized (3" or 5" is recommended for use with US, Inc. generators).

<u>Do not use</u> external grounds at electrical connections; see power supply manual for additional details.

TARGET PARAMETERS

Purity
Target material for the Mighty-MAK sputtering source is not confined to a minimum or maximum purity level. This parameter is dependent upon film requirements.

Surface
The mounting (bottom side) surface of the target should be smooth and flat to allow good contact to source. The top and bottom of the target should be parallel for best deposition uniformity.

TARGET DIMENSIONS (SEE PAGE 9)

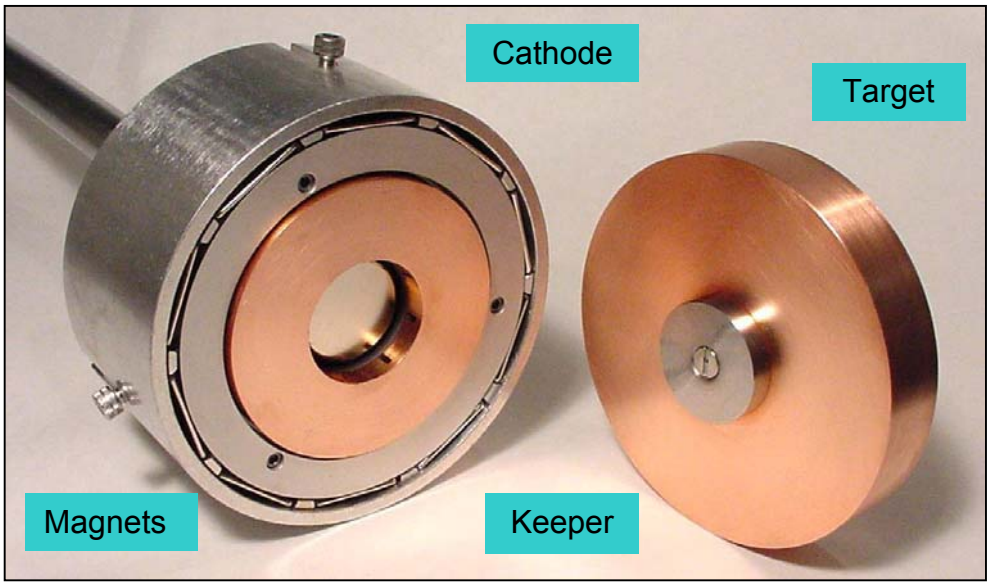
Simplicity in Sputtering

INTRODUCING

The MAK

Planar Magnetron Sputtering Source

Target Installation on the MAK



TARGET KEEPER

The Mighty-MAK sputtering sources have the unique feature of attaching the target using magnetic force. This is Accomplished by attaching a magnetically permeable "keeper" (see appendix) to the bottom of the target. This keeper coupling with the magnetic field of the Mighty-MAK source provides sufficient force to clamp and center the target, eliminating the need for complex mechanical clamps.

Machinable Materials
The target keeper can be attached to machinable materials by drilling and tapping the target to 90% of it's thickness and attaching the keeper using a vented flat head screw.

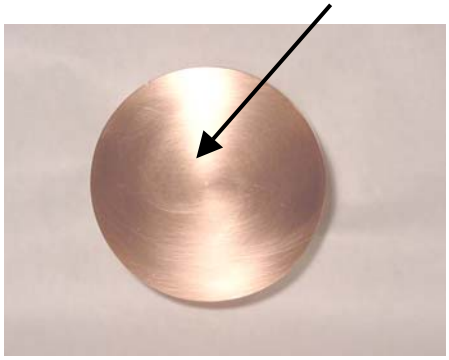
TARGET MOUNTING OF THE MAK
MACHINABLE MATERIALS

By attaching a magnetic keeper to the target, the MAK source uses the magnetics of the gun to hold the target in place.

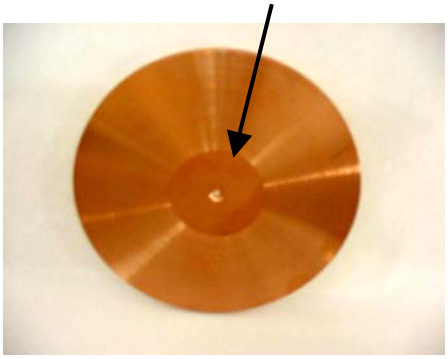
If you have old targets, NO PROBLEM! Drill and tap your existing targets as shown and attach the metallic keeper.

Then, snap the target into place. It's that simple!

Target Material

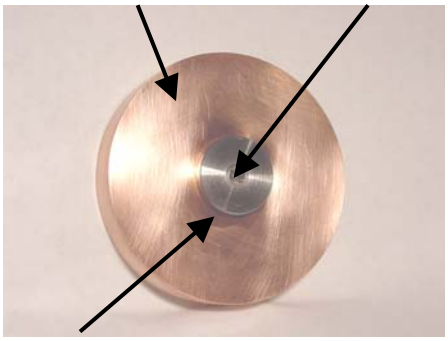


Target Material with
Drilled and Tapped Hole



Target Material
with Keeper

Mounting
Screw



Keeper

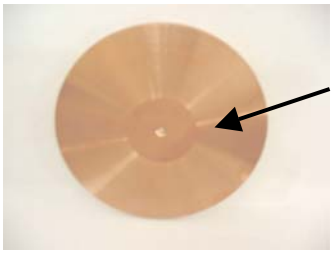
Non-Machinable Materials
Ceramic and oxide materials, a copper backing plate containing a magnetic keeper should be used. The target must be bonded to this backing plate and this bond must be able to withstand a temperature of 220°C.

TARGET MOUNTING OF THE MAK

NON-MACHINABLE MATERIALS

Backing Plates

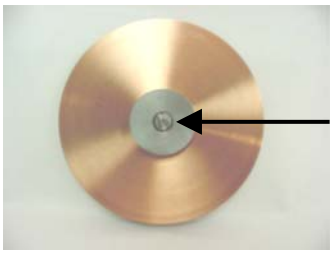
Ceramics, oxides, and any other non- machinable targets are commonly bonded to a copper backing plate for all sputtering sources.



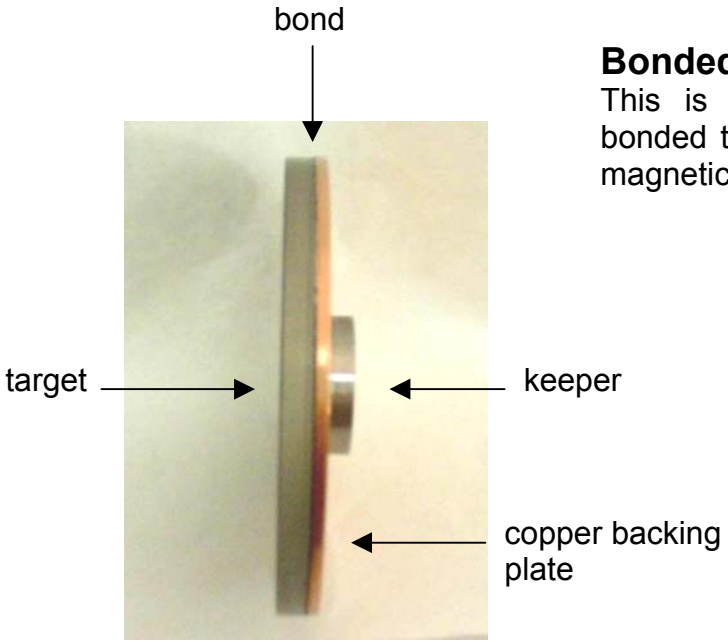
Cu plate with drilled and tapped hole

MAK Backing Plates

The MAK sputter source uses the same backing plate, but with a magnetic keeper attached. The keeper holds the target in place without a mechanical clamp.



Keeper with screw



Bonded Target - Example

This is an example of a SiO_2 target bonded to a copper backing plate with a magnetic keeper attached.

Copper Backing Plate Specifications (See Appendix A)

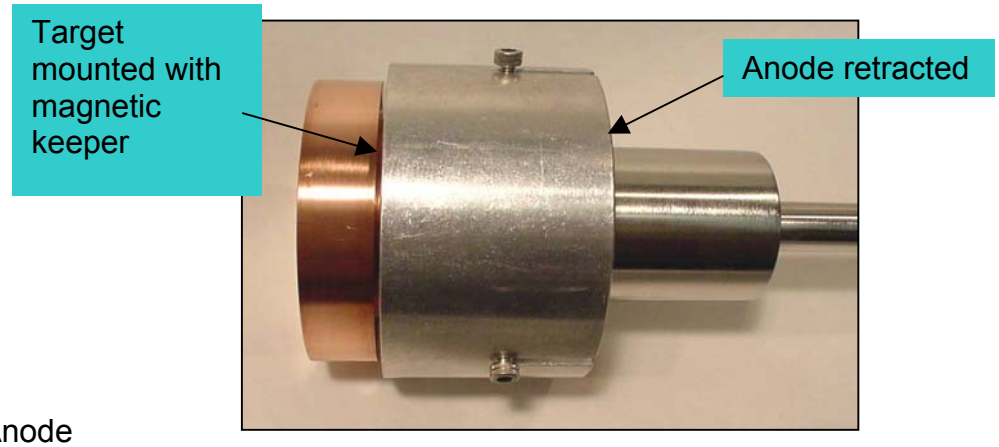
MAK 1.3” Copper Backing Plate	Part Number: MAK-130-BP
MAK 2” Copper Backing Plate	Part Number MAK-200-BP
MAK 3” Copper Backing Plate	Part Number MAK-300-BP
MAK 4” Copper Backing Plate	Part Number MAK-400-BP
MAK 6” Copper Backing Plate	Part Number MAK-600-BP

Caution

Failure to use thermal contact paste or a thin metal foil as an interface layer between the target and the copper cooling block can cause over heating and may damage the MAK source and/or target.

Simplicity in Sputtering

MAK with target installed



Remove the Anode

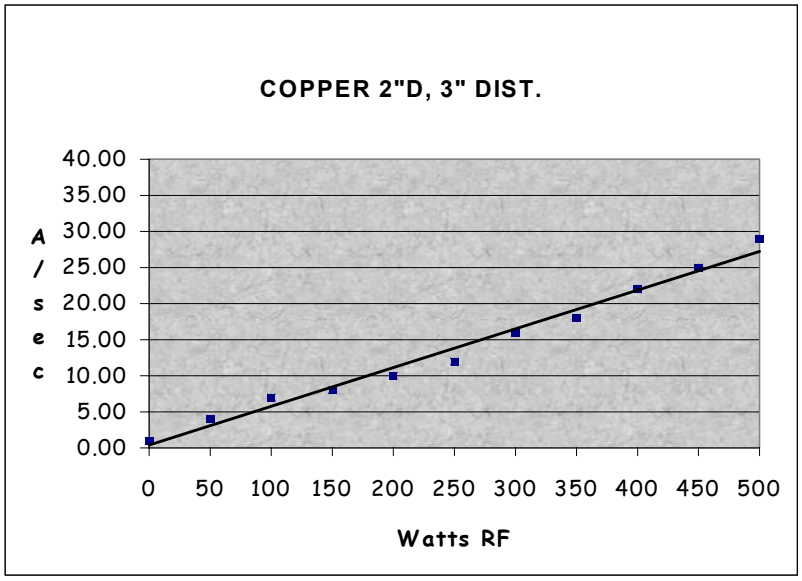
1. **Spread a small amount of thermal contact paste on the top of the copper chill block. The past should be spread evenly and so thin you can see through it.**
   a) *If the thermal contact paste is not used a thermally and electrically conductive foil e.g. indium ~0.005” thick with a donut shape slightly smaller than the cathode/chill block must be placed between the block and the target.*
   b) Place the target at the center of the source assuring that the magnetic keeper has been properly positioned in the recessed center magnet cavity. Twists slightly to evenly distribute the thermal contact paste.
   c) Replace Anode

CAUTION: Magnetic Keeper MUST be used with magnetic materials…

Thermal Contact Paste
Part Number TP-832

RATE VS. POWER

When gathering rate data, it is also desirable to take rates at different power levels. These values can be plotted to produce a graph similar to the one shown.



Please Note: For approximating DC rates, multiply by 1.75.

RELATIVE SPUTTERING RATES OF 50 MATERIALS

The following list of materials and their relative sputtering rates are normalized to copper as 1.00. Copper is a convenient and readily available material to use as a reference. Once the rate of copper is known, then the other 49 may be approximated.

Please Note: These rates may vary from those of other periodicals, due to the conditions under which the rates were taken.

Element (or compound) Cu = Rate of 1.00

Ag	2.06		Gd	1.17		Rh	0.74
Al	0.73		Ge	1.05		Ru	0.66
Al_2O3	0.15		Glass	0.23		Sb	3.68
Au	1.76		Hf	0.67		Si	0.39
Be	0.22		Ir	0.61		SiC	0.36
Bi	10.00		Mg	0.26		SiO	0.27
C	0.05		MgF	0.03		SiO2	0.45
CdS (1010)	2.39		Mn	0.99		Sm	1.14
CdTe	0.64		Mo	0.53		Sn	1.38
CoCr	0.58		Nb	0.44		Ta	0.43
Cu	0.60		Ni	0.65		Th	0.84
Dy	1.00		Os	0.5		Ti	0.38
Er	1.18		Pb	3.52		U	0.73
Fe	0.56		Pd	1.31		V	0.38
GaSa (110)	1.70		Pt	0.9		W	0.39
			Rb	4.55		Y	0.95
			Re	0.53		Zr	0.65

RELATIVE RATES OF SPUTTERING SOURCES VS DISTANCE

Rate data, for sputtering with small sources, is usually taken by making step samples and then measuring them with either profilometer or interferometer. A quartz crystal micro-balance type rate monitor may also be used. If a rate monitor is used, the geometry and the density of the deposit must be taken into account. Because of the uncertainties of rate monitor data, the most prudent course is to correlate the values taken with the rate monitor with those taken by step sample method.

If the distance from the substrate to the target is changed and the power remains constant, the rate of deposit will change. Now it is only necessary to find the ratio of the distances involved and the rate of the material at the known distance.

IF THE RATE AT 3" IS 15/sec.,

AND ONE WISHES TO KNOW THE RATE AT 4"

THEN THE RATIO IS 9/16.

MULTIPLY .563 BY 15

WHICH GIVES THE RATE AT 4" OF 8.445.

Remember many things are involved and this is only an approximation

WARRANTY CLAIMS

US, Incorporated products are warranted to be free from failures due to defects in material and workmanship for 24 months after they are shipped.

In order to claim shipping or handling damage, you must inspect the delivered goods and report such damage to US, Incorporated within 15 days of your receipt of the goods. Please note that failing to report any damage within this period is the same as acknowledging that the goods were received undamaged.

For a warranty claim to be valid, it must:
- be made within the applicable warranty period
- include the product serial number and a full description of the circumstances giving rise to the claim
- have been assigned a return authorization number (see below) by US, Incorporated or it's distributors

All warranty work will be performed at an authorized US, Incorporated service center. You are responsible for obtaining authorization (see details below) to return any defective units, prepaying the freight costs, and ensuring that the units are returned to the service center. US, Incorporated will return the repaired unit (freight prepaid) to you; repair parts and labor will be provided free of charge. Whoever ships the unit (either you or US, Incorporated) is responsible for properly packaging and adequately insuring the unit.

Authorized Returns

Before returning any product for repair and/or adjustment, call US, Incorporated or it's distributor and discuss the problem. Be prepared to give the serial number of the unit and the reason for the proposed return. This consultation call will allow us to determine if the unit must actually be returned for the problem to be corrected. If it is determined that the unit needs to be returned a Return Materials Authorization (RMA) number will be issued. This RMA number must be prominently displayed on the outside of any packages that are returned and included in all correspondence. Technical consultation is always available at no charge.

Units that are returned without authorization from US, Incorporated and that are found to be functional will not be covered under the warranty (see warranty statement, below). That is, you will have to pay a retest fee, and all shipping charges.

Warranty

The seller makes no express or implied warranty that the goods are merchantable or fit for any particular purpose except as specifically stated in printed US, Incorporated specifications. The sole responsibility of the seller shall be that it will manufacture the goods in accordance with its published specifications and that the goods will be free from defects in material and workmanship. The seller's liability for breach of an expressed warranty shall exist only if the goods are installed, started in operation, and tested in conformity with the seller's published instructions. The seller expressly excludes any warranty whatsoever concerning goods that have been subject to misuse, negligence, or accident, or that have been altered or repaired by anyone other than the seller or the seller's duly authorized agent. This warranty is expressly made in lieu of any and all other warranties, express or implied, unless otherwise agreed to in writing. The warranty period is 12 months after the date the goods are shipped from US, Incorporated. In all cases, the seller has sole responsibility for determining the cause and nature of the failure, and the seller's determination with regard thereto shall be final.