

SPUTTER SOURCES & SUBSTRATE HEATERS



MAK SPUTTER SOURCES

PRODUCT

Since the 1980's, MeiVac's US Components Division has acquired multiple exclusive manufacturing and distribution licenses for patented planar magnetron sputter sources from two prominent "Silicon Valley" research laboratories. With over 6,000 of these sources delivered worldwide, the US Components Division has become known as a leading manufacturer of sputter deposition sources, substrate heaters and associated hardware. Introduced in the 1990's, one of the sources, the MAK, rapidly became a standard in the industry. Noted for its simplicity, ease of use and resulting high reliability, the MAK source has been designed to present the smallest profile possible and deliver higher deposition rates than any comparable sputter sources. Because of its popularity, the MAK source has been used in the development of many of today's thin film processes. The MAK source is produced at MeiVac's San Jose, California U.S.A. facility.

PROCESS

Sputtering, which is a Physical Vapor Deposition (PVD) coating technique, is a common method of depositing both metal layers and insulating layers on a substrate. The layers being deposited can be elements such as Cu, Au, etc., alloys such as AlCu, NiFe, etc. or insulators such as SiO₂, TiN, etc.



4" MAK Linear
Manually Adjustable Source

COMPANY

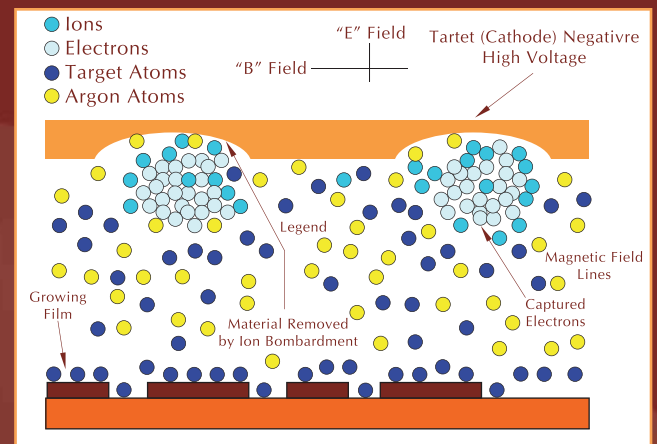
The MeiVac team has been serving the vacuum industry for more than 30 years. Founded as Comptech, the company established itself as a multi-faceted vertically integrated vacuum systems, components and services supplier. This capability continued to grow as the company was acquired by Alcatel in the 1980's and then re-acquired and renamed MeiVac in the 1990's. In May 2006, MeiVac acquired the Sputter Source business of US, Inc. and combined it with its Throttle Valve business to form the MeiVac US Components Division. Not only did this acquisition give MeiVac a strong addition to its product portfolio, it also gave the company access to an existing worldwide distribution network.

Today, MeiVac has a full array of internal design capabilities, including mechanical, vacuum, electrical, control, and software disciplines. Government certification standards for fabrication techniques (e.g. SST & Aluminum welding) are universally applied to life critical and production critical projects alike. Such design and fabrication capabilities permit close control over critical component quality and delivery.

PRINCIPLES OF SPUTTERING

Typically, a substrate (the item to be coated) is placed in a vacuum chamber opposite a target (made of the coating material being sputtered). The chamber is evacuated and then backfilled with a process gas (Argon). The gas is ionized with a positive charge, which creates plasma. Resulting ions are strongly attracted to the target, which carries a negative charge. The effect is a physical process similar to the interaction of billiard balls in a confined space. As the relatively large argon ions impact the target, atoms/molecules of target material are physically removed from the target. Due to its close proximity, a majority of sputtered atoms/molecules land on the substrate. The intent is for this material to arrive at the substrate with enough energy to form a thin, strongly attached film, one monolayer at a time.

Planar Magnetron Sputtering
CROSS SECTION OF A PLANAR MAGNETRON



PLANAR MAGNETRON SPUTTERING

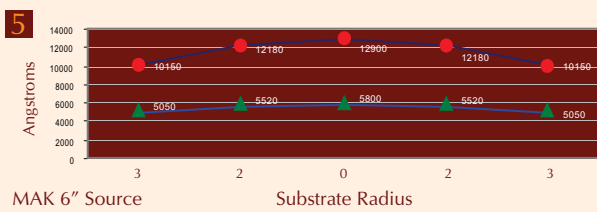
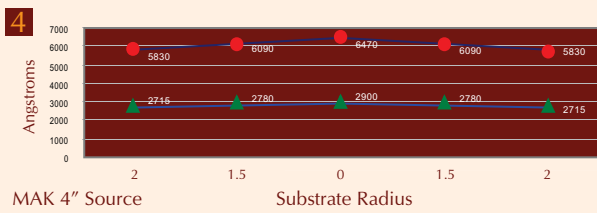
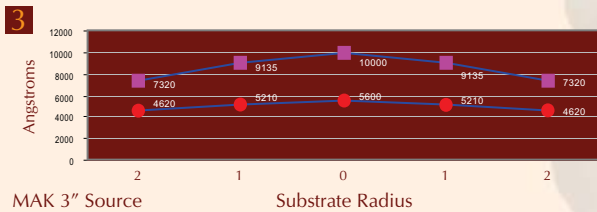
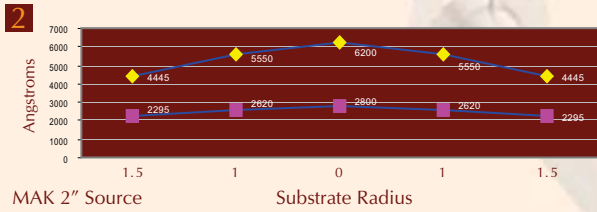
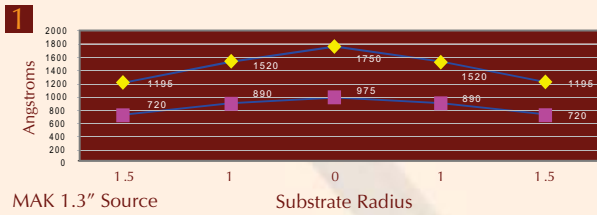
In conventional diode sputtering, electrons are created that escape the effective plasma area near the target. Some fly around the chamber creating undesirable side effects, such as heating the tooling. A magnetron-sputtering source addresses the electron problem by placing magnets behind, and sometimes, at the sides of the target. These magnets capture the escaping electrons and confine them to the immediate vicinity of the target. This increases the ion current (density of ionized argon atoms hitting the target) by a factor of 10 over conventional diode targets, resulting in faster deposition rates at lower pressures, which help to produce cleaner films.

FILM PROPERTIES

Deposition rate, film structure and layer uniformity of deposition materials are highly dependent on:

- Sputter efficiency of the material
- Deposition Power Level
- Source to substrate distance
- Process gas
- Substrate temperature
- Target erosion
- Position of anode
- Process Pressure
- Power Type (RF or DC)
- Angle of incidence
- Target Magnetic permeability
- Source configuration
- "Balance" of magnetic fields

UNIFORMITY DISTRIBUTION, GRAPHS 1-5



Uniformity of sputtered materials across the diameter of a substrate as a function of target size and source to substrate distance.

GRAPH 1-5

Source to substrate distance	Data Marker
2"	
3"	
4"	
6"	



RELATIVE RATES

Under identical power and geometric conditions target materials will sputter at different rates. The attached table provides relative rates for 50 common elements and compounds where Copper = 1.00.

Relative Rates Cu=1.0	
Ag	2.06
Al	0.73
Al2O3	0.15
Au	1.76
Be	0.22
Bi	10.00
C	0.05
CdS(1010)	2.39
CdTe	0.64
Co	0.58
Cr	0.60
Cu	1.00
Dy	1.18
Er	1.00
Fe	0.56
GaAs(110)	1.70
Gd	1.17
Ge	1.05
Glass	0.23
Hf	0.67
Ir	0.61
Mg	0.26
MgF	0.03
Mn	0.99
Mo	0.53
Nb	0.44
Ni	0.65
Os	0.5
Pb	3.52
Pd	1.31
Pt	0.9
Rb	4.55
Re	0.53
Rh	0.74
Ru	0.66
Sb	3.68
Si	0.39
SiC	0.36
SiO	0.27
SiO2	0.45
Sm	1.14
Sn	1.38
Ta	0.43
Th	0.84
Ti	0.38
U	0.73
V	0.38
W	0.39
Y	0.95
Zr	0.65

DETAILS OF TYPICAL RATES AND UNIFORMITY PERFORMANCES

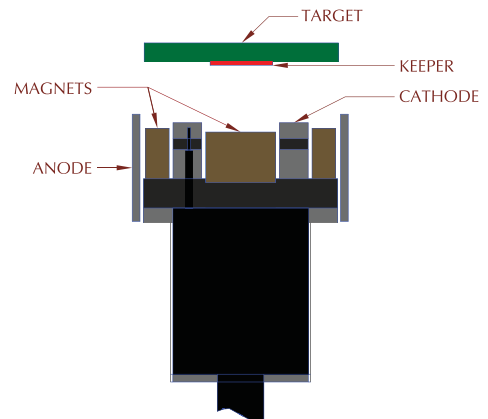
UNIFORMITY	MAK Model	Source to substrate distance	Rate Å/min Copper	Wafer Diameter, inches	Typical Uniformity	Wafer Diameter, Inches	Typical Uniformity	Cu Target Thickness	Watts@ 5 mTorr
Uniformity is heavily dependent on source to substrate distance and the relationship between source and substrate diameters	1.3"	2"	1,750	2	± 7%	3	± 20%	0.185"	200
		3"	975		± 5%				
	2.0"	2"	6,200	2	± 6%	3	± 16%	0.250"	500
		3"	2,800		± 3%				
	3.0"	3"	10,000	2	± 5%	4	± 15%	0.500"	1000
		4"	5,600		± 3%				
	4.0"	4"	6,470	3	± 5%	4	± 7%	0.500"	2000
		6"	2,900		± 2%				
	6.0"	4"	12,900	4	± 4%	6	± 12%	0.500"	3000
		6"	5,800		± 2%				

MAK SPUTTER SOURCES

Target is retained by the magnet structure with a simple keeper. Target exchange is accomplished in moments without disassembly.

MAK sources are designed to overcome limitations commonly found in other sources:

- Water channel is NOT part of the high voltage path
- Magnets are NOT in the water channel
- Target change does NOT require source disassembly
- Only one vacuum seal and NO water to vacuum seals
- Target requires NO clamping or bonding to cathode
- Magnetic Materials may be sputtered with the standard magnetic assembly in most applications.
- Operates in DC or RF modes
- Process pressures 0.5 – 600 mTorr
- Adjustable anode, improves uniformity, prevents build up and shadowing
- HV or UHV designs



OPTIONAL SOURCES AND FEATURES

- Gas injection, to deliver process gas directly to the area of the target, reducing residual gas interaction with the sputtering process.
- Right angle Flexmount, 0-45 degree angular adjustment
- Low Profile, Through wall
- Externally adjustable "Insitu" angular and linear sources
- RF & DC power supplies and RF matching networks
- Custom tailored flange mounted packages
 - Flange type and mount geometry specified by customer
- Shutters & Shielding
- Rotary Motion Feed through

MAGNETRON CONFIGURATION

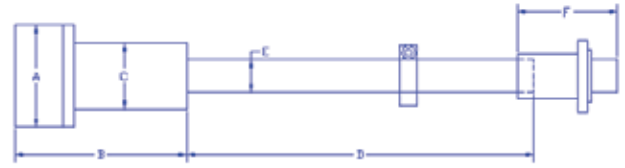
MeiVac offers a number of options to assist in achieving desired results. The standard model MAK source is mounted on a 12" (300mm) long support with a position clamp included. Water and power are contained at atmospheric pressure within this support. A 0.75"/19mm Quick Coupler vacuum feedthrough is required to integrate the source in the vacuum system and position it at the correct source to substrate distance.



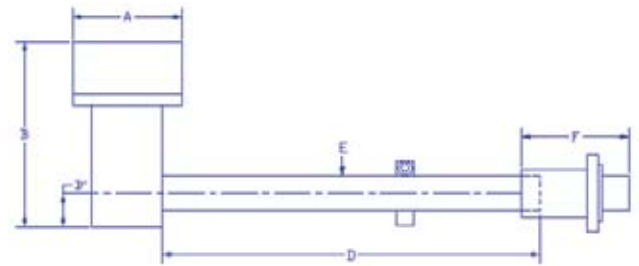
Operating Specifications

MAK Model	1.3"	2.0"	3.0"	4.0"	6.0"
Mounting Flange CF (O.D.)	4.5 in 114 mm	4.5 in 114 mm	6.0 in 152 mm	8.0 in 203 mm	10.0 in 254 mm
Target Diameter	1.3	2.0	3.0	4.0	6.0
Magnets	<i>Nd / Fe B</i>				
DC Max Pwr	350W	1000W	2000W	3000W	6000W
RF Max Pwr	200W	400W	750W	1200W	2000W
Cathode (V)	200 - 1000				
Discharge Current (Max amps)	1.00	3.00	5.00	7.00	10.00
Min Operating Pressure (mtorr)	0.5 - 600				
Flow Rate (gpm)	0.6	0.8	0.8	1.0	2.0

Circular Source, manually adjustable to substrate distance



Right Angle Source, manually adjustable along X-axis.

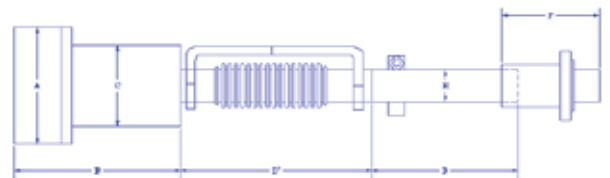


Dimensional Specifications

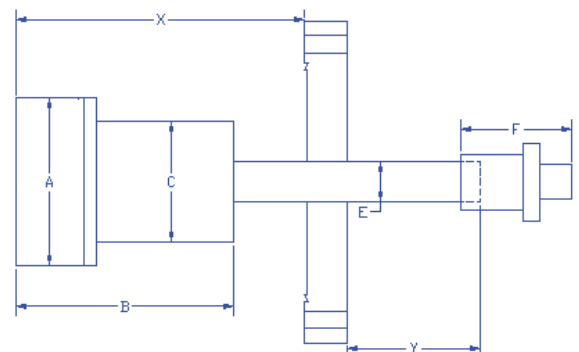
MAK Model	1.3"	2.0"	3.0"	4.0"	6.0"
Dimensions in Inches					
A	Ø1.50	Ø2.33	Ø3.38	Ø4.45	Ø6.55
B	4.45	3.91	4.35	4.60	6.75
B'	0.71	0.71	0.66	0.66	*
C	Ø2.325	Ø1.50	Ø2.25	Ø2.25	Ø4.50
D	12.0	12.0	12.0	12.0	12.0
D'	4.5	4.5	4.5	4.5	4.5
E	Ø0.75	Ø0.75	Ø0.75	Ø0.75	Ø1.25
F	2.3	2.3	2.3	2.3	2.3

* Please consult factory

Flexmount Source, manually adjustable, 0-45 degrees angular and 12" source to substrate distance



Flange Mounted Source



X and Y dimensions are customer specified

Flange mounted single and multiple sources available at customer request, ISO, ANSI, JIS, CF.

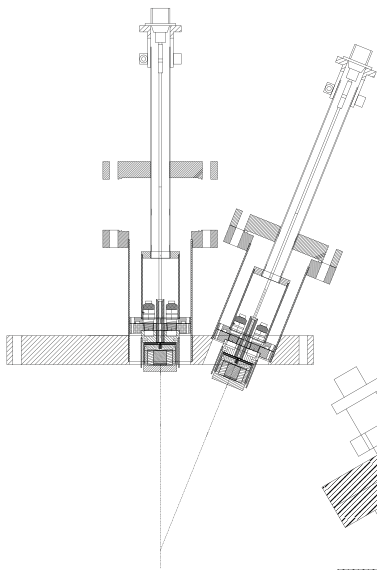
Options include:

- Shutters
- Shielding
- Gas injection
- External adjustment of source to substrate distance or angle.

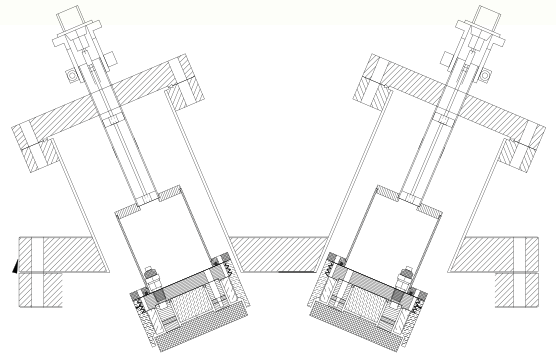
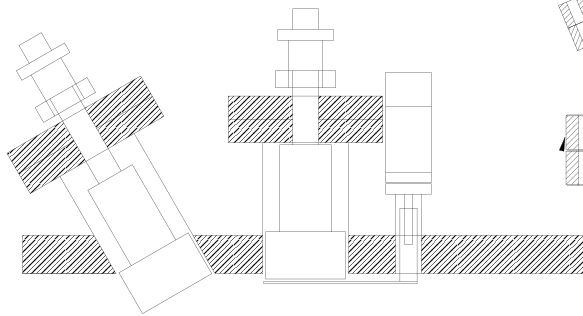
MAK Multi-source

Project/Process specific Custom packages including:

- Sources
 - Standard with linear adjustment
 - Flexmount internally adjustable angular
 - Insitu externally adjustable linear
 - Insitu externally adjustable angular
- Shutters
- Shields
- Gas Injection
- 1.3", 2", 3", 4", 6" sources
- Two or more guns on a flange
- 8" – 24" CF, ISO, ANSI, JIS



Design Examples



RF Power Supplies, Matching Networks

- 300 W, 600 W, 1000 W RF
- CE marked
- Programmable
- Air Cooled
- RS-232 / 422 / 485
- RF DC voltage Control

DC Power Supplies

- 500W, 1KW, 1.5KW, 2.5KW, 5KW
- Pulsed DC available with 5KW
- Arc suppression circuitry
- Some CE marked configurations available
- Regulation in power, voltage, and current modes

SUBSTRATE Heaters

MeiVac Heaters are configured for two general types of applications, Samples and Wafers.

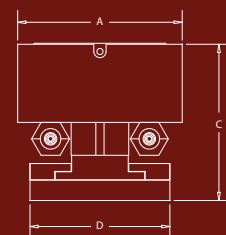
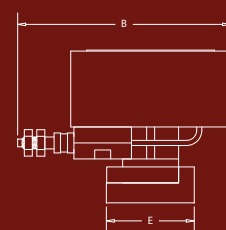
- Sample Blocks may be drilled and tapped for sample holding clips. Note this is per customer specification at an additional charge.
 - Sample Blocks are made of Haynes Metal and MUST be pre baked at atmosphere by the customer at or exceeding the desired operating temperature prior to use.
 - Haynes metal heater blocks are compatible with the Silver Thermal Paste, which is sold as an accessory by MeiVac.
- Wafer Blocks are Inconel metal and are wafer size specific. Wafer pockets are machined into the surface of the heater blocks.
 - Inconel is NOT compatible with Silver Thermal Paste.

See manual or Web Site for proper preparation and care of heater blocks.



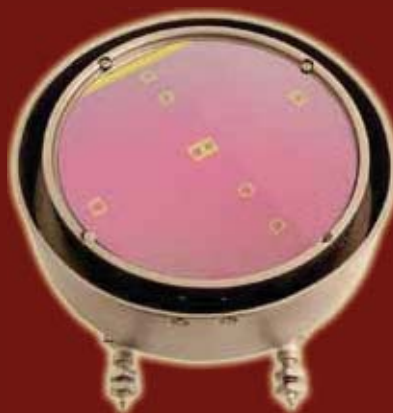
SU-300-HH
"Sample" Heater Block

Part Number	SU-200-HH	SU-200-IH	SU-300-HH	SU-400-IH	SU-600-IH
Stage Type	Sample	Wafer	Sample	Wafer	Wafer
Size (inches)	2	2	3	4	6
Dimension (inches)	<i>Refer to sketches</i>				
A	2.50	3.00	3.50	5.00	6.75
B	3.33	3.48	3.83	5.60	7.38
C	2.37	2.37	2.37	3.30	3.30
D	2.12	2.62	2.62	3.00	3.00
E	1.38	1.38	1.38	2.30	2.30
Max. Temperature	950C	950C	950C	950C	950C
Temp. Uniformity	+/-1%	+/-1%	+/-1%	+/-2%	+/-2%
Area of uniformity	center 1.25" dia.	2" dia.	center 2.25" dia.	4" dia.	6" dia.
Temp. Repeatability	12 C	12 C	12 C	13 C	13 C
Ramp time to 950C	12 min	12 min	13 min	22 min	30 min
Cool-down time	35 min	35 min	40 min	3 hrs	4 hrs
Max. Current	10 A	10 A	9 A	14 A	14 A
Max. Voltage	45 V	45 V	85 V	85 V	135 V
Input power	AC/DC	AC/DC	AC/DC	AC/DC	AC/DC
Heater resistance	5 ohms	5 ohms	10 ohms	6 ohms	10 ohms
Heater material	Haynes	Inconel	Haynes	Inconel	Inconel



OPTIONAL ACCESSORIES

- Deluxe mounting stands, adjustable bracket with X,Y, & Z movement mounted on 2.75", 4.5" & 6" rotatable CF flanges.
- Mounting stands with power and thermocouple feedthroughs
- 18" Hook-up kit, which includes:
 - One thermocouple with 18" lead wire
 - Two 0.050" OFHC Copper Power Leads 18" long
 - Ceramic tubes and beads for insulation and protection from plasma



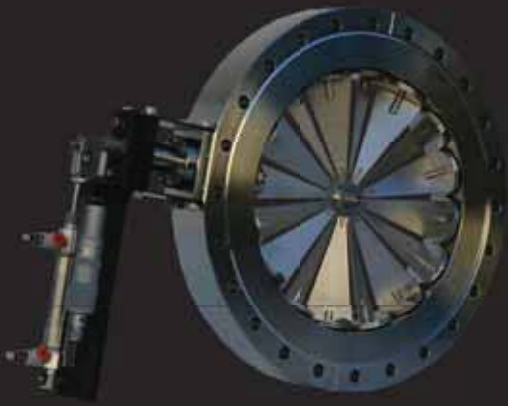
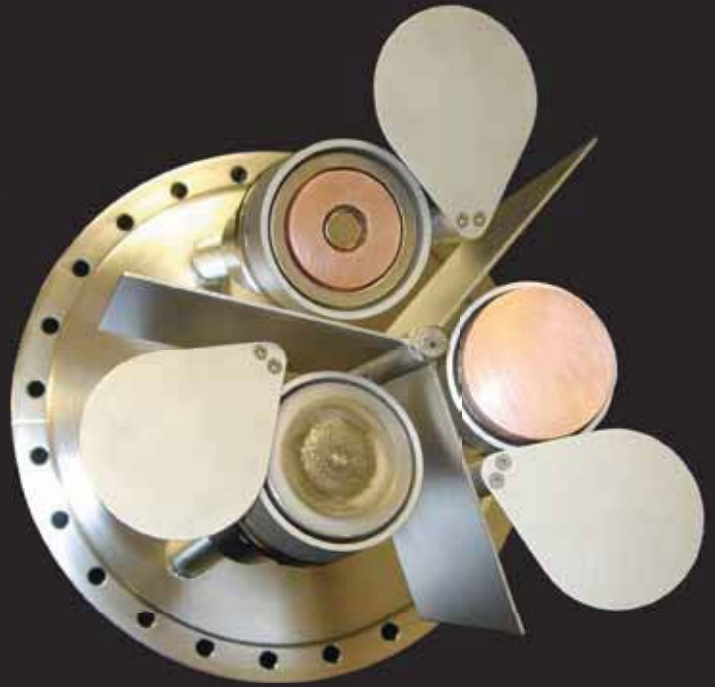
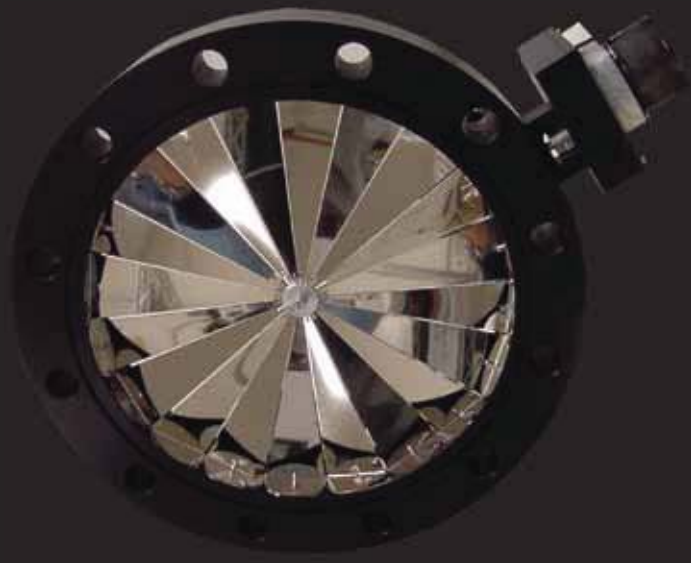
SU-400-IH "Wafer"
Heater Block

FEATURES

- UHV Compatible
- O2 Compatible
- Electrical bias capability
- Unprecedented temperature uniformity

APPLICATIONS

- Sputtering
- Laser ablation
- Ion beam deposition
- ECR, MOCVD, and others



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