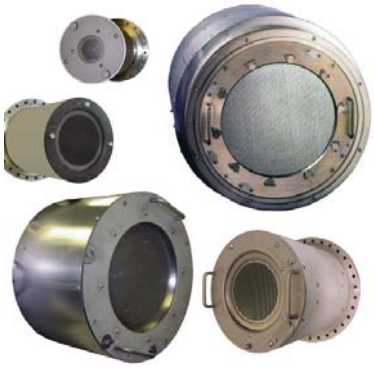
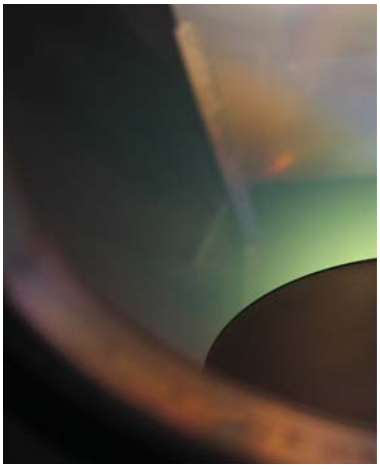
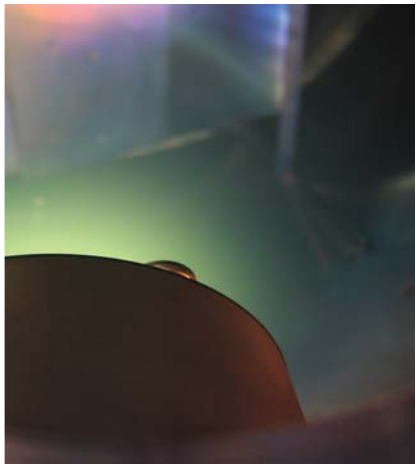
KAUFMAN & ROBINSON

The Ion Beam Authority℠

Gridded Ion Beam Sources







Ion Beam Assisted Deposition

In-situ Substrate Precleaning

Ion Beam Sputter Deposition

Surface Modification

Ion Beam Etching

Ion Beam Figuring

Surface Polishing & Smoothing

Ion Beam Trimming and Tuning

KRI Gridded Products

RFICP40
RFICP100
RFICP140
RFICP200
RFICP300

KDC 10
KDC 40
KDC 75
KDC 100
KDC 160

Mean free path, $T_{target} = T_{incident}$

$$\lambda = 1/\sqrt{2}\,nQ$$

Mean free path, $T_{target} = 0$

$$\lambda = 1/nQ$$

Distribution of path lengths

$$I = I_o \exp(-x/\lambda)$$

Debye length

$$\lambda_D = \sqrt{\varepsilon_o k T_e / n_e e^2}$$

Boltzmann equation

$$n_e = n_{eo} \exp(V_p / kT_e)$$

Child's law

$$j = (4\varepsilon_o/9)\sqrt{2e/m}\,(V^{3/2}/x^2)$$

Bohm conductivity ⊥ B

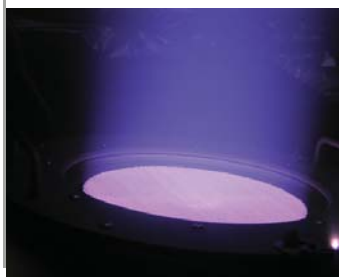
$$\sigma_B \approx e n_e / 16$$

Temperature–energy equivalence

$$1\ ev = 11{,}600\ K$$

Mean Maxwellian speed

$$\bar{v} = \sqrt{8kT/\pi m}$$



KAUFMAN & ROBINSON
The Ion Beam Authority

- Credibility
- Innovative
- Quality

Applications

- Adhesion
- Film Densification
- Chemical Conversion
- Texturing
- Pinhole Free Films
- Ultra Thin Film Precision
- Microstructure Control
- Nanostructured Surface
- Anisotropic Etching

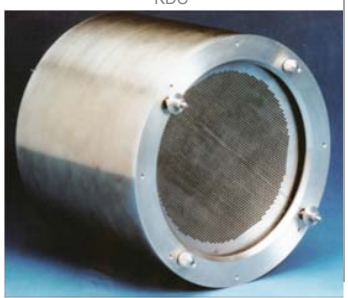
Gridded Beam Sources

- Low Cost
- Industrial
- Remote Plasma
- Directed Beam
- Beam Shaping
- Precision Control
  - Ion Current
  - Ion Energy

Design Features

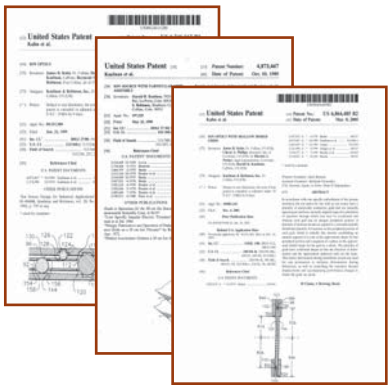
- Self-aligned Ion Optics
- Inert & Reactive Gases
- Large Ion Energy Range
- High Ion Current Densities
- Collimated, Divergent and Focused Beams

KDC



The Ion Beam Authority

Kaufman & Robinson offers gridded Ion Beam Products. Our products include broad-beam Gridded Ion Sources and automated power supplies controllers. All designs are straightforward which easily retrofit into existing vacuum systems, or easily integrate into new OEM systems.

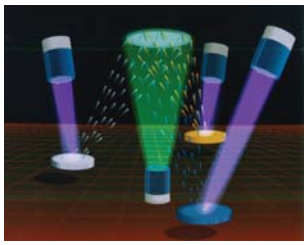


Since 1978, Kaufman & Robinson (KRI), Inc. has designed and built broad-beam ion sources for the vacuum processing community including both manufacturers and researchers. The designs of the gridded ion beam products were developed with our world-recognized expertise in plasma physics, ion source design, and power control engineering.

Currently, KRI holds more than 20 active patents in ion beam and plasma technology, including its innovative designs in multi-aperture ion optics technology.

Meeting Your Application Needs

KRI's knowledge in material applications is captured in our product relevence. Our products are proven process tools which are connected to real results. For example: These products output a stable regulated beam ideally suited for dry plasma etching, surface treatment and thin film growth applications which include:



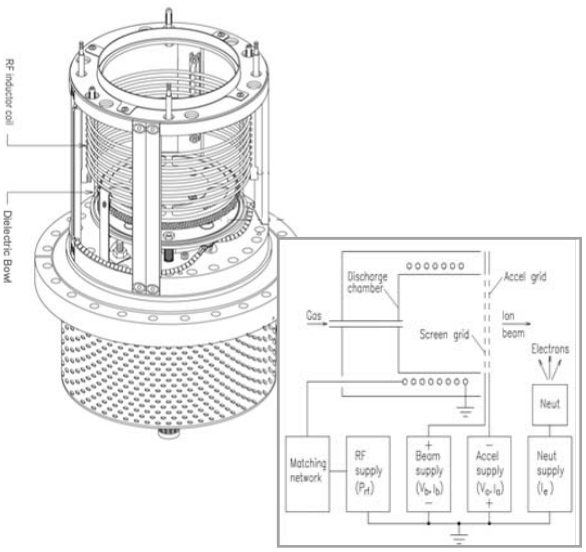
- *Ion Beam Assisted Deposition*
- *In-situ Substrate Precleaning*
- *Ion Beam Figuring*
- *Ion Beam Etching*
- *Surface Modification*
- *Ion Beam Sputter Deposition*

Gridded Series of Broad Beam Ion Sources

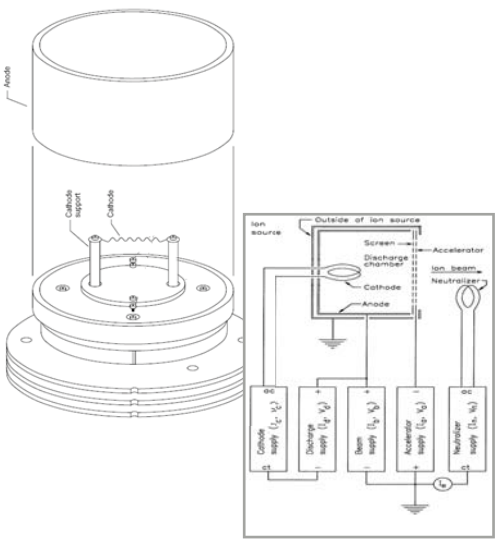
The versatile gridded series of broad beam ion sources are available in different sizes which covers both R&D and high yield production requirements. Large ion beam sources meet critical output performance for uniform coverage over wide process zones. The large ion energy range permits low energy operation to minimize bombardment damage and heat on sensitive substrates while high energy operation enables high rate sputtering processes.

All gridded models feature patented self-aligned ion optices, electron source neutralizer and either a DC or RF discharge chamber. Our gridded products are fit into two catagories: Kaufman DC (KDC) Style or RF Inductive Coupled Plasma (RFICP) Style.

RFICP Discharge Configuration



KDC Discharge Configuration



Electron Source Neutralizers

Non-immersed
(outside of beam)
Neutralizer

Immersed (in beam)
Filament Neutralizer

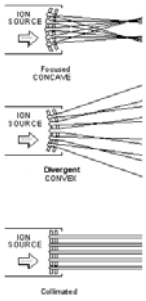
The gridded source can be configured with different neutralizers. The available neutralizer options include simple filaments or non-immersed electron sources. These neutralizers allow stable processing on dielectric materials, eliminating charge build-up effects.

All electron sources tightly control the electron emission current whether it is inexpensive filament designs or non-immersed models used for extended run time and low temperature requirements.

- *LFN2000* *for up to 2 A emission current*
- *SHC1000* *for up to 5 A emission current*
- *MHC1000* *for up to 10 A emission current*

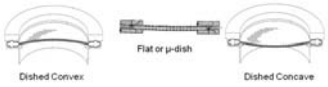
Electron Source Neutralizers

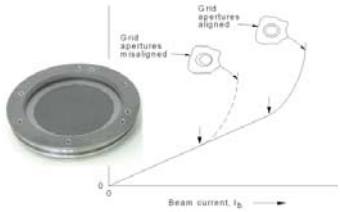
OptiBeam™ Ion Optics



Our ion optics assemblies come in a variety of configurations, sizes and outputs. The multi-aperture grids which seat in the ion optics assemblies are made from thermally stable materials such as Molybdenum and Pyrolytic Graphite. The grid sizes range from 1cm to 38cm diameters and they can be fabricated into flat or dished shapes. The ion optics designs can produce beams which diverge, focus or collimate from the ion source. Two grid ion optic assemblies are standard, while three grid ion optic assemblies are employed in specialized applications.

One of the core benefits in our gridded ion beam products is self-aligning ion optics technology. This technology eliminates the traditional grid alignment procedure. Consequently, the result is consistent and precise aperture position which ensures repeatable and optimized beam characteristics.





Product Options

The eH models can be equipped with optional hardware to tailor the product to the customer's process and installation.

- **Mounting Options**
  - **Extended Mount Vacuum Feedthrough**
  - **Remote Vacuum Feedthrough**
  - **Direct Mount Vacuum Feedthrough**
- **Angular Mounting Bracket**

- **Mass Flow Controllers**
- **In-vacuum Cables**
- **Ion Source Switchbox**

KDC 75 w/ O_2 Beam

Electron Sources

- Neutralization
- Beam Divergence
- Plasma Stabilization
- Low Energy
- ESD Control
- Dielectric Substrates

Ion Optics

- 1 to 38cm Φ size
- No Alignment Procedure
- Extended Grid Lifetime
- Optimize Divergence
- Minimizes Maintenance
- Maximizes Beam Current
- Reproducible Beam

Optional Accessories

- Lower MTBM
- Low Voltage Operation
- Installation Flexibility
- Process Optimization
- Long Filament Lifetime

Collimated Ar Beam

RFICP

Features

- Switch Mode
- Digital Control
- Low Stored Energy
- MFC Gas Control
- Single Botton Enable
- Integrated Control
- Remote Interfaces
- Recipe Storage
- RF Automatching

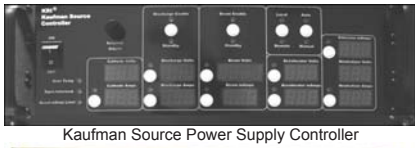
Ion Beam Sources

- Standard configurations
- Optimized configurations
- Application specific
- Controlled ion energy
- Controlled current density
- Controlled beam shape

Power Supplies

All KRI power supplies feature advanced primary switched power modules with output control to protect power supply and load. Upgrades from basic configurations to advanced configuration are easily achieved by replacing or adding modules. Depending upon the model, the power supplies deliver either AC, DC or RF signals with output powers ranging from 100 to 2000W.

- *Powers and controls plasma discharge, ion beam and neutralizer parameters*
- *Feedback control stabilizes beam output for precision process control*
- *Short and arc management through protection circuits*
- *Constant and stable ion beam parameter control over complete operating range*
- *Selection of operational modes to fit application*



Kaufman Source Power Supply Controller

Ion Optics Controller (Screen + Accelerator Grid)

LFN Neutralizer Controller

RFICP Source Power Supply Controller
(RF Auto Matching)

Auto Controller: Gas Control, Recipe Storage, Operational Modes

Nominal Specifications

Product	RFICP40	RFICP100	RFICP140	RFICP200	RFICP300
Discharge	RFICP	RFICP	RFICP	RFICP	RFICP
Ion Beam Current (I_B)*	>100mA	>350mA	>600mA	>800mA	>1500mA
Ion Beam Energy (V_B)	100-1200V	100-1200V	100-1200V	100-1200V	100-1200V
Beam Size @ grid	4cm Φ	10cm Φ	14cm Φ	20cm Φ	30cm Φ
Beam Type	Collimated, Convergent, Divergent				
Typical flow	3-10sccm	5-30sccm	5-30sccm	10-40sccm	15-50sccm
Gases	Ar, Kr, Xe, O_2, N_2, H_2,others				
Typical Pressure	<0.5mTorr	<0.5mTorr	<0.5mTorr	<0.5mTorr	<0.5mTorr
Length	5.0” (12.7cm)	9.25” (23.5cm)	9.7” (24.6cm)	11.8” (30cm)	14” (35cm)
Diameter	5.3” (13.5cm)	7.52” (19.1cm)	9.7” (24.6cm)	16.1” (41cm)	20.9” (53cm)
Neutralizer**	LFN 2000				

Product	KDC 10	KDC 40	KDC 75	KDC 100	KDC 160
Discharge	DC Thermionic	DC Thermionic	DC Thermionic	DC Thermionic	DC Thermionic
Ion Beam Current (I_B)*	>10mA	>100mA	>250mA	>400mA	>650mA
Ion Beam Energy (V_B)	100-1200V	100-1200V	100-1200V	100-1200V	100-1200V
Beam Size @ grid	1cm Φ	4cm Φ	7.5cm Φ	12cm Φ	16cm Φ
Beam Type	Collimated, Convergent, Divergent				
Typical flow	1-5sccm	2-10sccm	2-15sccm	2-20sccm	2-30sccm
Gases	Ar, Kr, Xe, O_2, N_2, H_2,others				
Typical Pressure	<0.5mTorr	<0.5mTorr	<0.5mTorr	<0.5mTorr	<0.5mTorr
Length	4.5” (11.5cm)	6.75” (17.1cm)	7.9” (20.1cm)	9.25” (23.5cm)	9.92” (25.2cm)
Diameter	1.52” (4cm)	3.5” (9cm)	5.5” (14cm)	7.6” (19.4cm)	91” (23.2cm)
Neutralizer**	All Sources offer Immersed Filament				

* Can Depend On Ion Optics

** Other Neutralizers are Availble

KAUFMAN & ROBINSON
The Ion Beam Authority℠

Kaufman & Robinson, Inc.
1306 Blue Spruce Dr. Ste A
Fort Collins, CO 80524-2067
USA

Tel: +1 (970) 495.0187
Fax: +1 (970) 484.9350
Email: sales@ionsources.com
Web: www.ionsources.com