

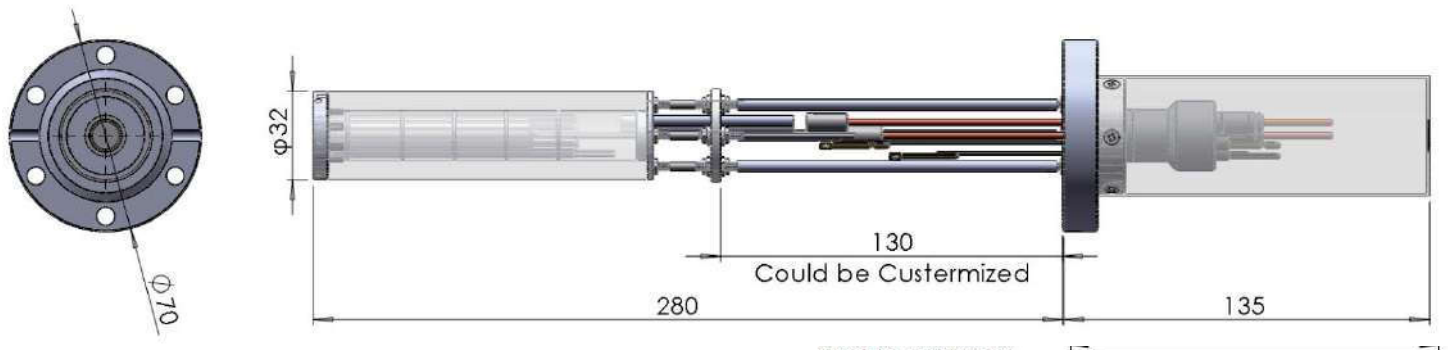


Section 5. Evaporators

- 5.1 Standard Effusion Cell
- 5.2 Cold Lip Effusion Cell
- 5.3 Near Ambient Effusion Cell
- 5.4 High Temperature Effusion Cell
- 5.5 High Capacity Effusion Cell
- 5.6 E-Beam Evaporators
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- 5.9 Alkaline Metal Evaporator
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Section 5. Evaporators

Standard Effusion Cell



All dimensions in mm

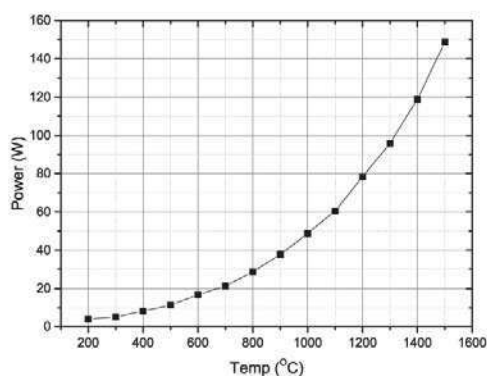
Mounting Flange	Crucible Size (cc)	Working Temperature (°C)	Degas Temperature (°C)	Thermocouple	Stability (°C)	Part Number
NW38CF (2.75 inch)	10	100~1100	1200	K	0.1	EC2LT
		300~1400	1500	C	0.1	EC2MT

*Test with Heat Pro-II PID Power Supply

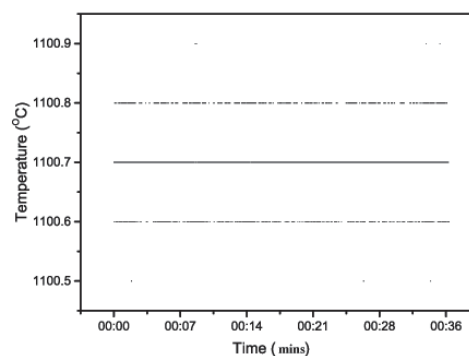
The Standard Effusion Cell is designed for evaporation or sublimation of a variety of elements and compounds in the temperature range from 100°C up to 1500°C.

The heating element is constructed from alloy filament supported by PBN ring which provides for excellent temperature uniformity within the crucible, high heating efficiency even at the crucible lip, and easy replacement of different crucibles.

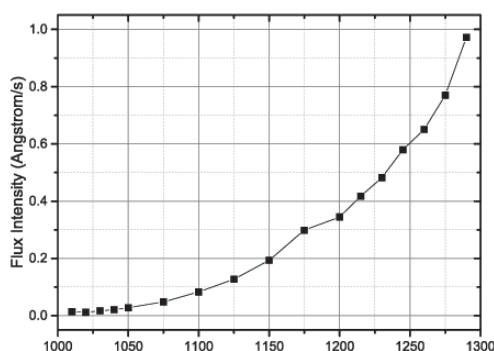
All evaporators are tested and degassed before shipment with factory test report.



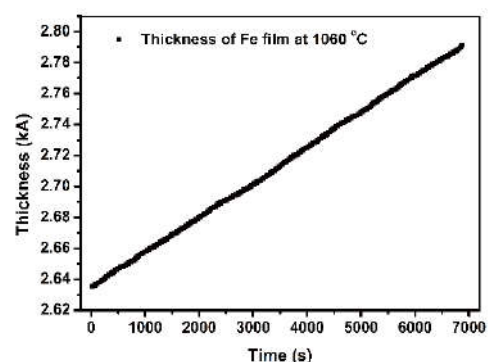
Power Test



Temperature Stability



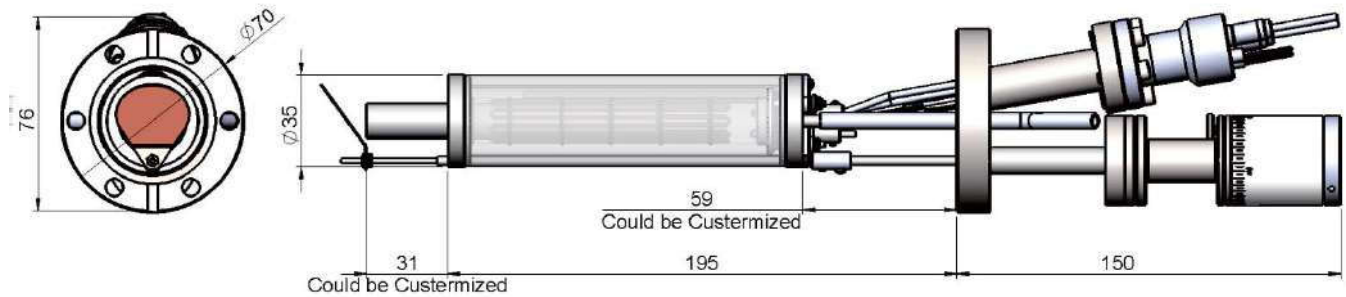
Flux Test (MgF₂)



Flux Stability Test

Section 5. Evaporators

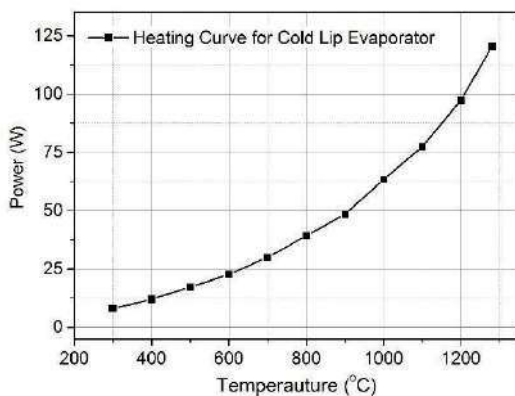
Cold Lip Effusion Cell



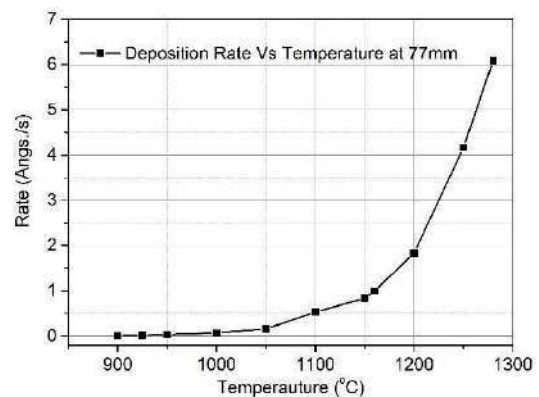
All dimensions in mm

A cold lip filament Effusion Cell is a revised version of the standard evaporators. The heating element is special wired that the heating power is reduced at the lip of the evaporator. This fact and some additional shielding leave the crucible lip clearly cooler than the lower parts. This is required for Aluminum evaporation for example.

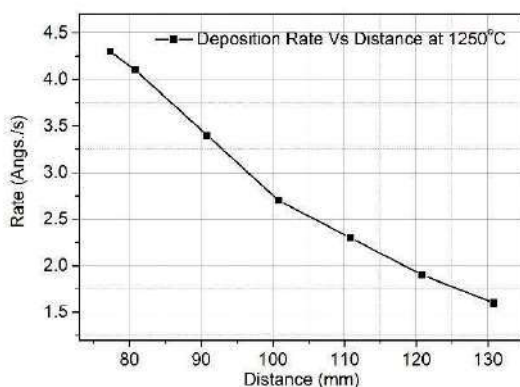
A flux guide cap could be installed on the cold lip evaporator so that the flux is more focused to the substrate.



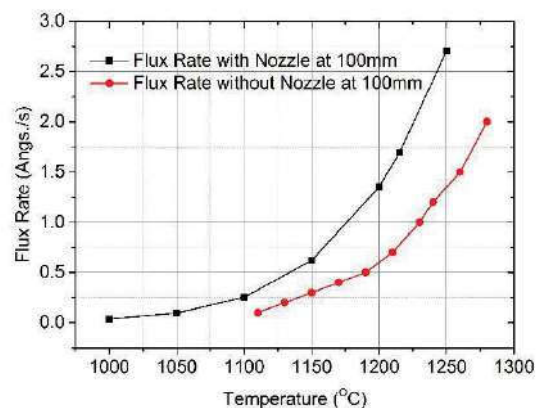
Power Test



Deposition Rate vs Temperature



Deposition Rate vs Distance



Influence of Nozzle on Deposition Rate

Section 5. Evaporators

Near Ambient Effusion Cell



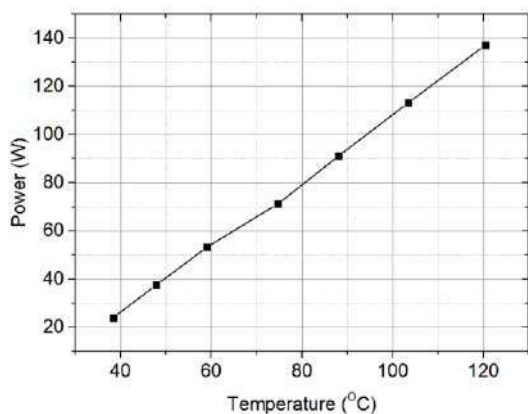
All dimensions in mm

- Working Temperature: -50 °C -150 °C
- Sensor: K Type, others on request
- Temperature Stability: ± 0.01 °C
- Max Degas Temperature: 300°C
- Mounting Flange: DN40CF. others on request
- Max outer diameter: 36mm
- Length: 290mm (could be customized from 190-400mm)
- Crucible Capacity: ~20cc
- Crucible Material: Quartz, others on request
- Water Cooling: Integrated Water Cooling
- Shutters: Manual/Pneumatic on Optional
- Valved: Optional
- Linear Motion: optional (standard 150mm)

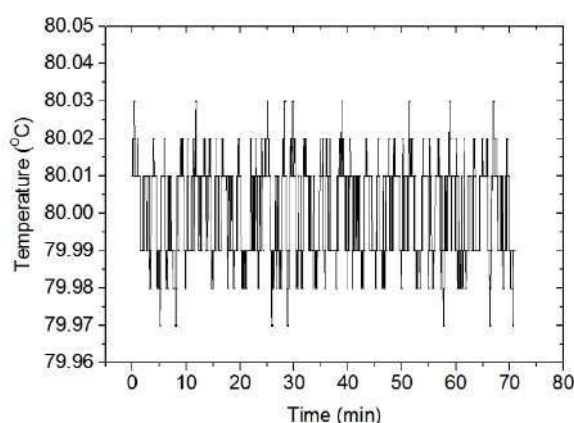
For many critical applications where stable but low temperature vaporization is required (for example organic material), FERMI INSTRUMENTS offers Near Ambient Effusion Cell.

One annealed copper block is acting as thermo conductor as well as heat sink thus balanced cooling and heating is achieved between -50 °C and 150 °C. Cooling during bakeout and standby is also possible to freeze the change which reduces consumption and keep the system in UHV condition.

Together with the Heat Pro-II Power supply, temperature stability up to 0.01 °C has been realized which guarantees very accurate beam flux control. The logic control utilized by Eurotherm PID controller ensures that the ramp up temperature does not over shoot the set point which is essential for some sensitive materials.



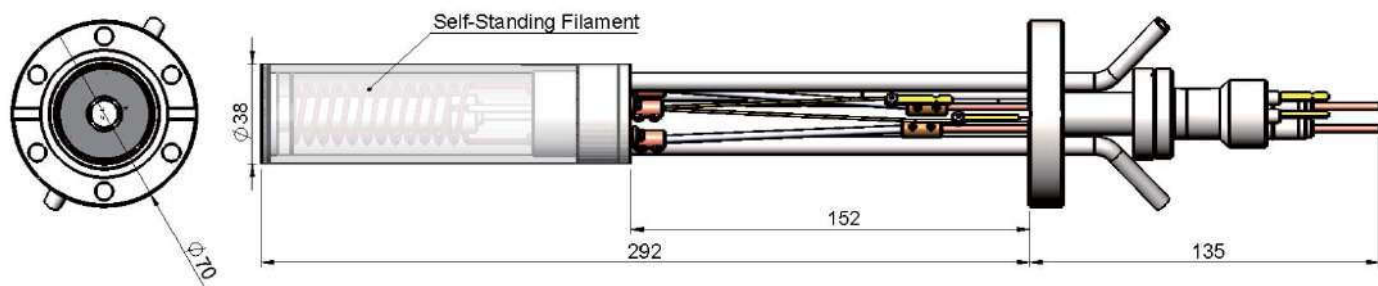
Power Test



Temperature Stability

Section 5. Evaporators

High Temperature Effusion Cell



All dimensions in mm

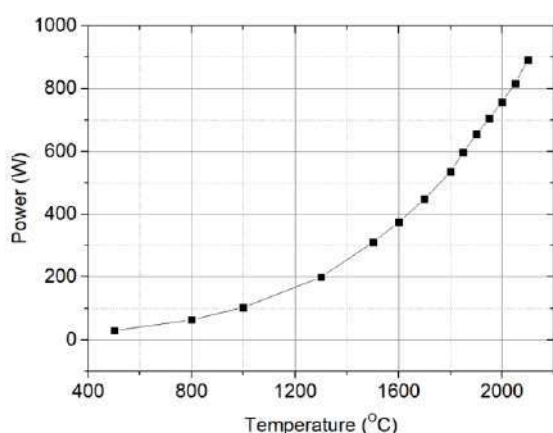
The High Temperature Effusion Cell is designed for clean UHV operation up to 2000°C. The concept of ceramic support heating element is no long valid here as:

- Most ceramic is semiconducting at such high temperature thus insulating is difficult.
- PBN decompose significantly above 1500 °C.

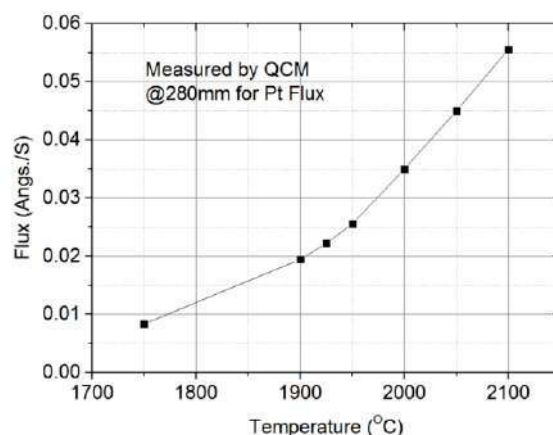
To overcome these issues, one self-standing filament is manufactured which is the key point for this high temperature evaporator. With this free-standing filament of thick tungsten wire, the ultimate version is capable of even 2000°C.

To prevent the flange being heated by the radiation of the heating element and cool the electrode during max power running, one internal water cooling stage is included with high temperature evaporator. However external water cooling shroud is always recommended to prevent the chamber being heated up.

Mounting Flange	Crucible Size (cc)	Working Temperature (°C)	Degas Temperature (°C)	Thermocouple	Stability (°C)	Part Number
NW38CF (2.75 inch)	10	800~1800	1900	C	0.1	EC2HT
		1000~2000	2000	C	0.1	EC2UHT



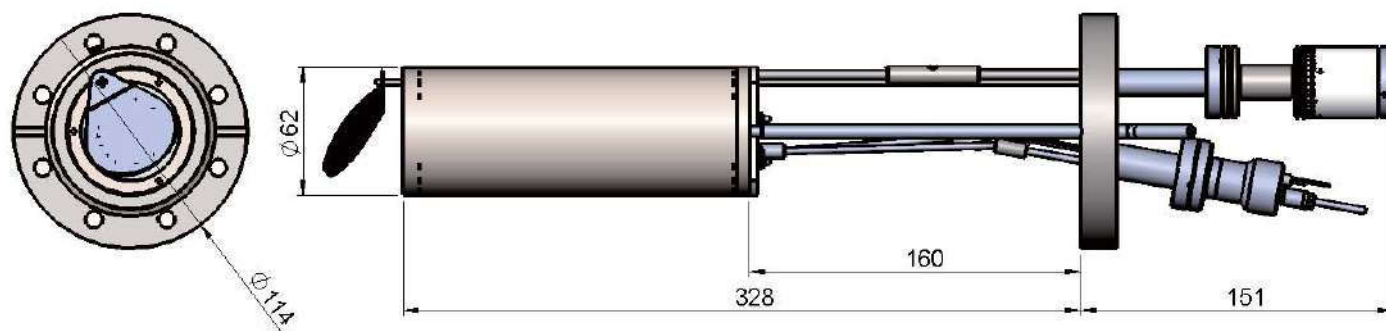
Power Test



Flux Data

Section 5. Evaporators

High Capacity Effusion Cell



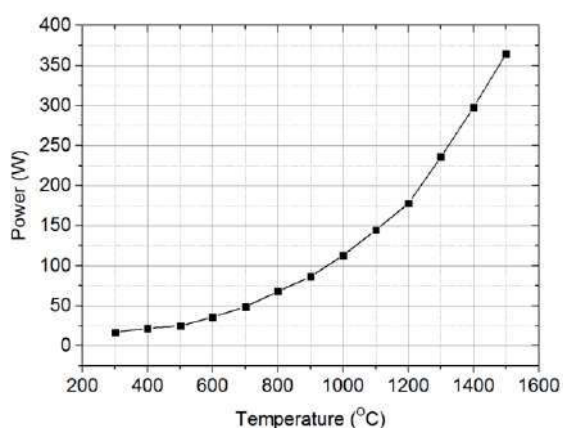
All dimensions in mm

For some special applications, such as production MBE systems, high throughput and stability are both critical. Thus, high capacity Effusion Cell are designed to meet the requirement.

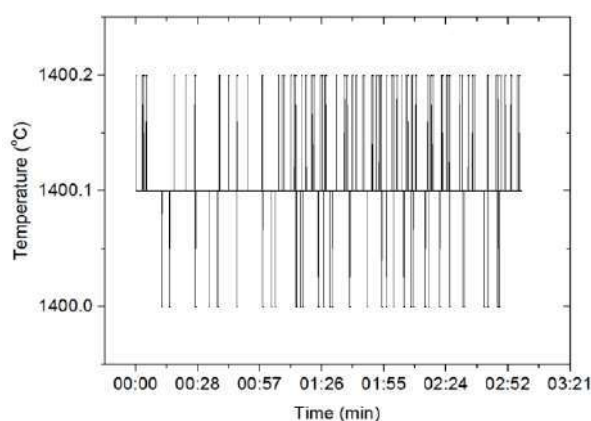
Similar to the standard Effusion cell, the crucible is heated by a wire filament supported by PBN rings which proves to be a uniform and effective heating. However, by increase the mounting flange from NW38CF to NW63CF, the crucible volume increase significantly from 10cc to 30 CC. The scale up crucibles will need more powers which will leads to undesirable degas for the UHV system. To prevent this from contaminating the UHV environment, the shielding around the heating element is optimized and integrated water cooling shroud is a standard element in high capacity effusion cells.

The compatible design makes this cell compatible with standard MBE systems. Besides standard filament configurations, Hot Lip/Cold Lip and dual filament configurations are also available to meet the specified requirements of the evaporation materials.

Mounting Flange	Crucible Size (cc)	Working Temperature (°C)	Degas Temperature (°C)	Thermocouple	Stability (°C)	Part Number
NW63CF (4.5 inch)	30	100~1100	1200	K	0.1	HCEC2LT
		300~1400	1500	C	0.1	HCEC2MT



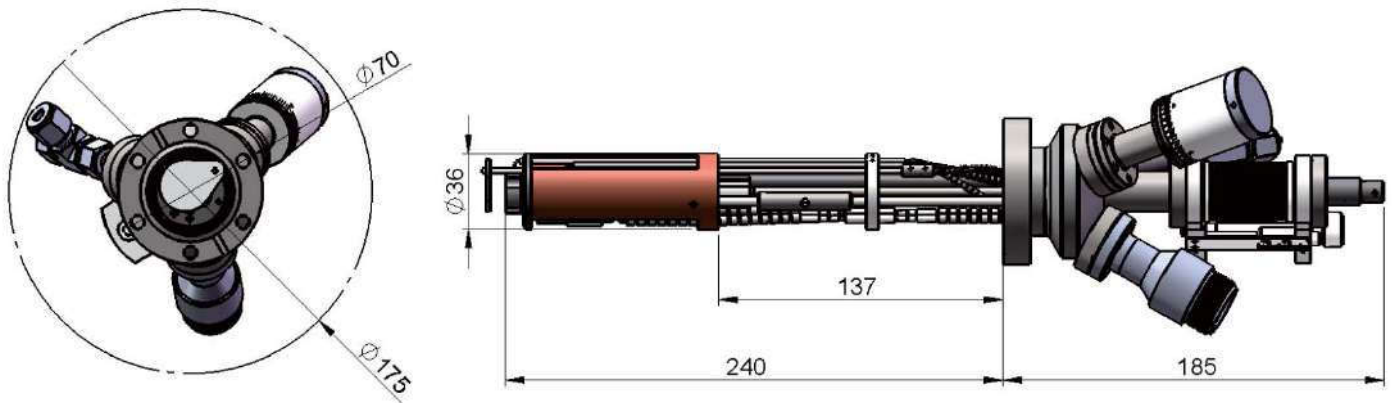
Power Test



Temperature Stability

Section 5. Evaporators

E-Beam Evaporator

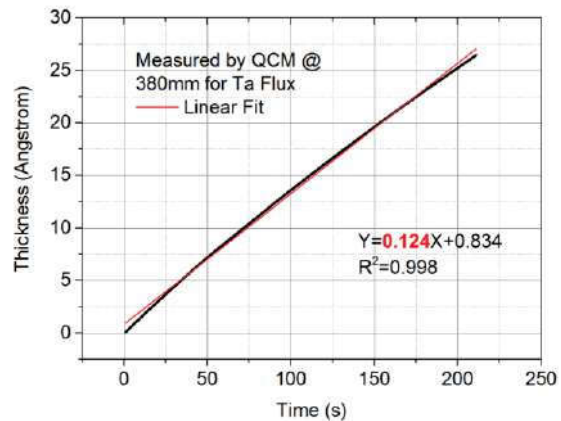
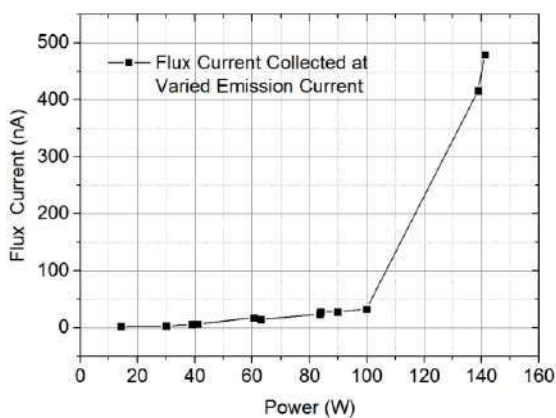


All dimensions in mm

Effusion Cells with different configurations have proven their capability in evaporating most elements in a controllable and stable manner. However, there is still limit on the effusion cells, with the wired filament design, the highest temperature one could achieve is around 2000 degrees which has pushed the tungsten filament to the limit. This is still below the evaporating point of many refractory metal such as Ta/ Mo et al., The e-beam evaporator pushed the highest working temperature to around 3000 degrees by electron bombardment from the surrounding filament to a rod form material or crucibles.

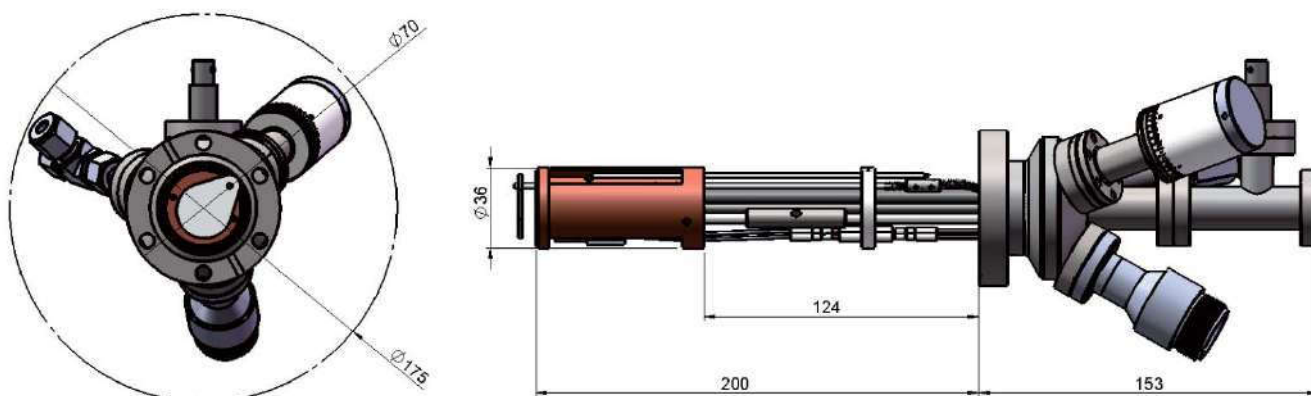
The heated zone is enclosed in a water-cooled copper shroud which keeps the degassing in a very low level. By tuning the input power from 0 to 300 W max, flux control from $<0.1\text{\AA}/\text{min}$ to $>50\text{\AA}/\text{min}$ is achieved for many materials. A 25mm (max. 50mm) stroke linear translator is fitted with the evaporator to support the movement of rod material and guarantee the rod tip always in the optimized position.

The e-beam evaporator includes power supply with intelligent front plate for control of filament current/voltage and emission current. It will generate enough power to evaporate the thickest rods (4 mm) and is also robust enough to survive misuse without the dire consequences seen in more complex failure-prone electronics



Section 5. Evaporators

Gas Cracker Source



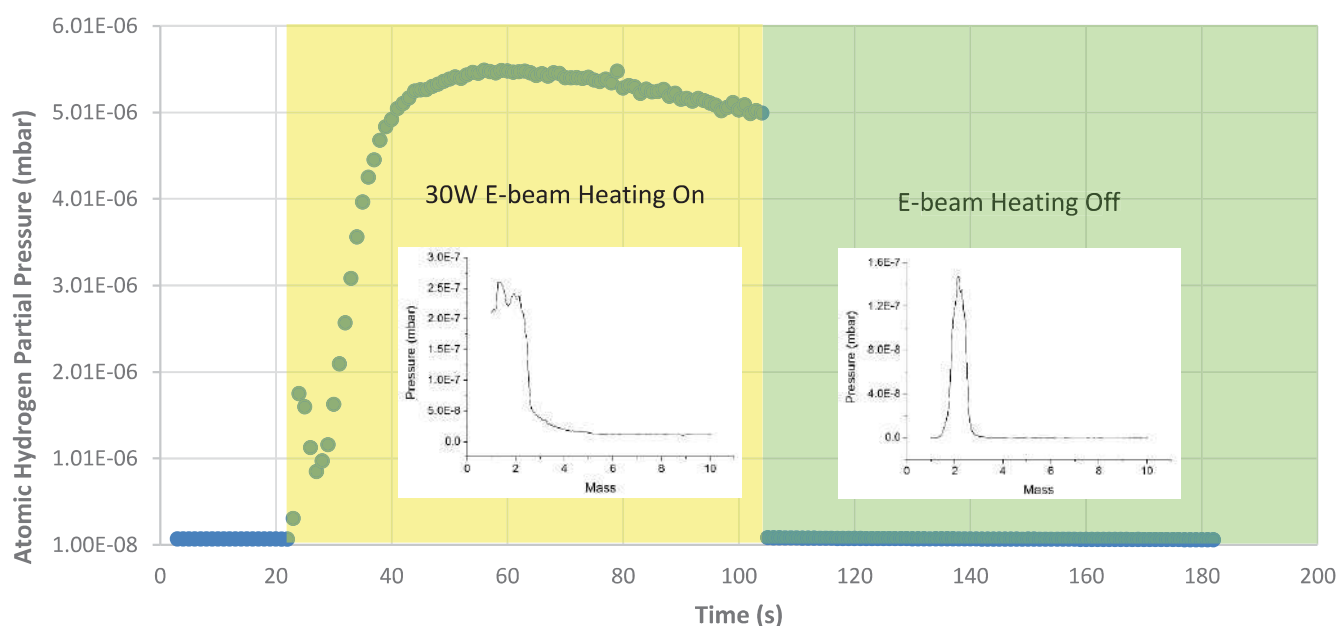
All dimensions in mm

Atomic gas beams such as hydrogen atom beam are widely used for substrate treatment, this is usually done by introducing regulated gas flow through a heated metal capillary. The gas molecular would then dissociate at high temperature and inject into the vacuum.

Considering the very high temperature requirement of the heated capillary, e-beam heating would be the most effective way. Our gas cracker source is designed based on our e-beam evaporator while replacing the metal rod with a refractory metal capillary. With very low power input the capillary could be heated above 1900 degrees and the thermal load on the chamber is negligible, due to the surrounding water cooling and small diameter aperture.

The source comes with a VAT all metal leak valve for regulating the gas flow which allow switching on and off the atom flux within several seconds. Short exposures can be terminated by a shutter (option S) which attenuates the hydrogen atom flux down to the detection level.

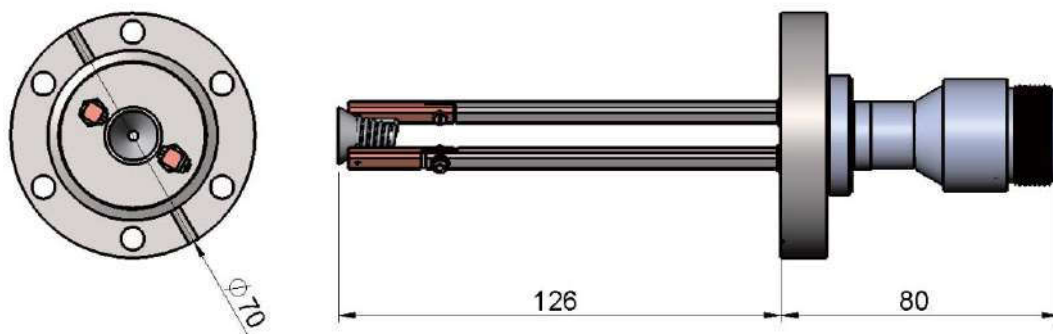
So far, the gas cracker source has been only operated with hydrogen and oxygen. The source could perhaps be used as well as a radical beam source by decomposing other molecules at temperatures up to 3000 K. Please inquire for your special application.



*Mass Spectrum taken by SRS RGA 100 at 200mm distance.

Section 5. Evaporators

Compact Evaporator

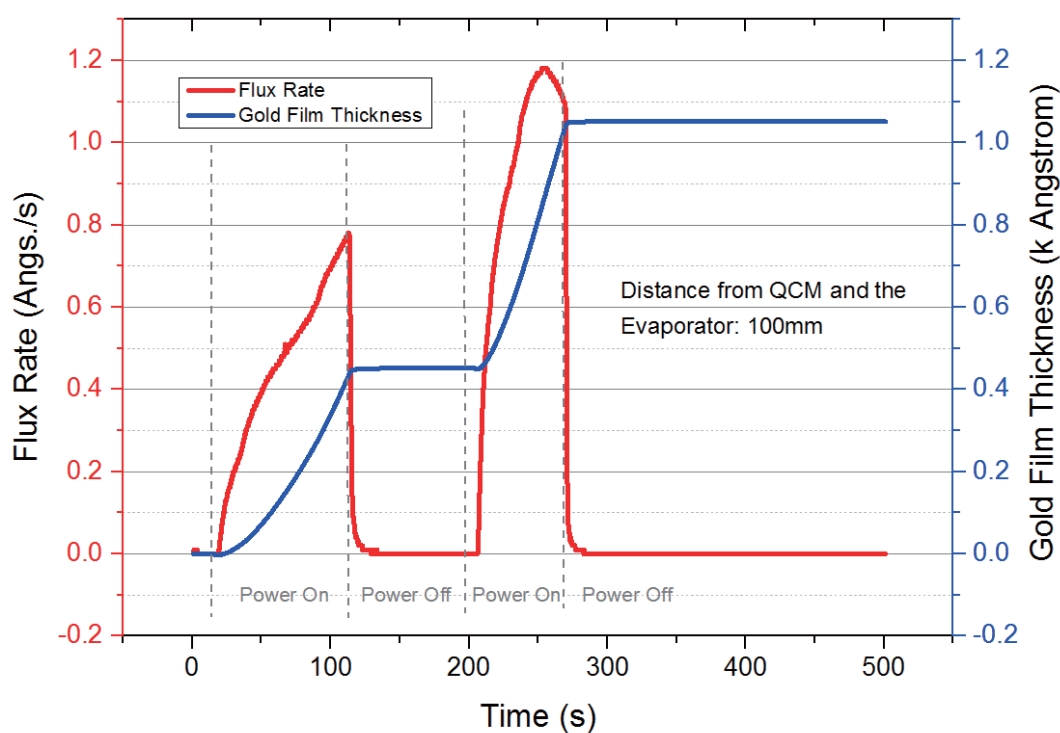


All dimensions in mm

For some occasions, a quick and afford evaporation method would be required, for example making gold/silver contact on thin films or some reference gold layer. Effusion cells will then be a too luxury and complex option as flux precision and stability will not be taken into consideration.

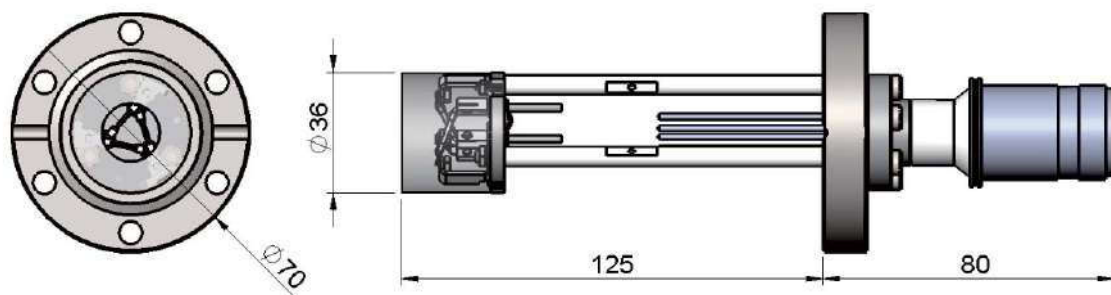
Compact evaporators are then offered as an easier way for material deposition, compared with other effusion cells, it has

- Less mechanically complex and could be ramped up/down in a much faster way;
- Smaller dimensions and easier to install;
- Easier to fill and service;
- Larger orifice diameters to increase material flux, suitable for contact preparation;
- Higher deposition rates;
- Low cost;



Section 5. Evaporators

Alkaline Metal Evaporator



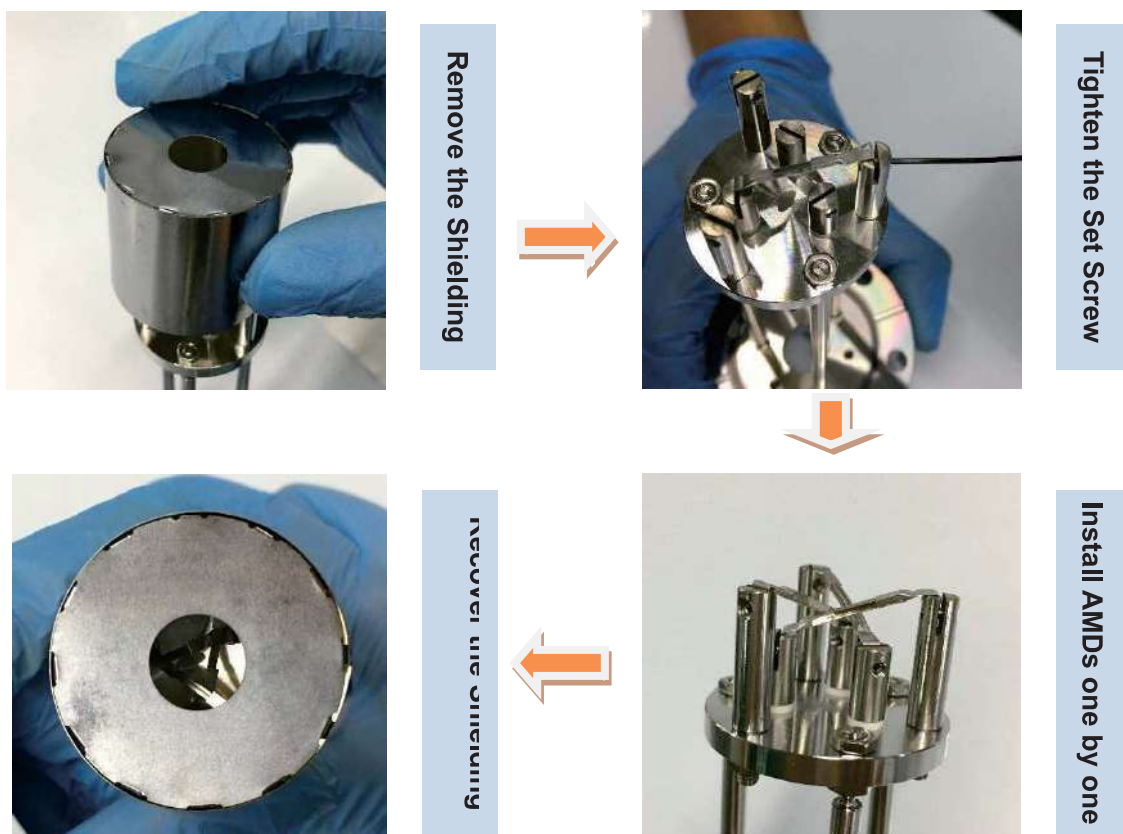
All dimensions in mm

Alkaline Metal are used widely in electrical doping and preparing cathode films, however the chemical property of alkaline metal is so active that makes it impossible to load pure alkaline metal into effusion cells without the application for glove box or vacuum transfer box.

An alternative way is to use the Alkali Metal Dispensers (AMD), it is an efficient and safe method of depositing ultrapure alkali metals such as Cesium, Potassium, Sodium, Rubidium and Lithium. AMDs keep the alkali metal pure in the form of a stable salt combine with a getter material. The presence of the getter guarantees an ultrapure environment during the alkali evaporation.

The Alkaline Metal Evaporator is designed to be compatible with SAES AMD model X/NF/xx/12/FT10+10 and could accept up to 3 AMDs at a time. Deposition of individual channel or co-deposition could be chosen at the power supply. All AMDs could be easily accessed and replaced at the time of service. No other consumable part on the alkaline metal evaporator.

Four Steps to Instal the AMD



Section 5. Evaporators

Accessories



DC Power Supply



Shutter Unit



External Cooling with Shutter

Section 5. Evaporators



Crucible Material	Al ₂ O ₃	PBN	BeO	ZrO ₂	Y ₂ O ₃	Graphite	Quartz	Ta	W
Working Temp. (°C)	1600	1400	1700	1800	2000	2000	1200	2500	3000
Compatible Elements	Au	Al	As	CaO	Actinides	Ti	CaF ₂	Cu	Pb
	Ag	Au	Be			Pt	Cd	Si	V
	Cd	S	Ce				K	Pb	Au
	Ce	Sn	Co				Zn	Ba	Ag
	Co	Te	Ni						
	Cu	Pb							
	Fe								
	GaN								
	Zn								
	MgF ₂								

Standard Crucible Volume: 10cc