OXFORD APPLIED RESEARCH

**Ultra-clean operation**

**Sub-monolayer control**

**Software programming**

**Intrinsic rate monitoring**

# mini e-beam

## evaporators

## Focussing on the most important features for UHV deposition:


The Oxford Applied Research mini e-beam evaporators are employed to deposit ultra-pure films of refractory materials. The deposition rate is highly controllable, allowing the instruments to be employed in Surface Science or thin-film applications, with full control between < 0.1Å/min and 50Å/min possible for many materials. It is also possible to co-evaporate materials, with independent regulation of the deposition rate for four materials from a single power supply.

The evaporators all share a consistent design philosophy, which focuses on the most important features for UHV deposition: low contamination, low particulate generation and high reliability. Our evaporators deliberately use no moving parts, allowing *direct watercooling* of the target-holder which in turn leads to extremely efficient heat transfer. During tungsten evaporation at >3000°C, for example, the temperature of structural components and adjacent pockets remains below 35°C in our four-pocket device. This eliminates the temperature rise and subsequent contamination seen in less well-cooled devices. Furthermore there is no risk of particulate generation, bellows failure or internal seizing of moving parts.

### Principle of Operation

The evaporant can be fitted either as a solid rod or contained within crucibles. The rod/crucible is held at high voltage during operation, which acts to draw an electron current from a nearby hot filament. The energetic impact of the electron beam raises the temperature of the evaporant, creating a hot tip on the rod or a heated 'oven' in the case of a crucible. With a sufficiently elevated temperature, the material will begin to evaporate. In four-pocket devices, each pocket is equipped with an independently regulated filament and is enclosed by cross-contamination shields.

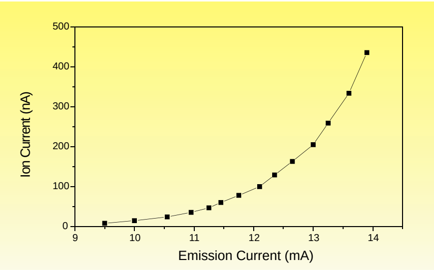
### Ion Current Monitoring

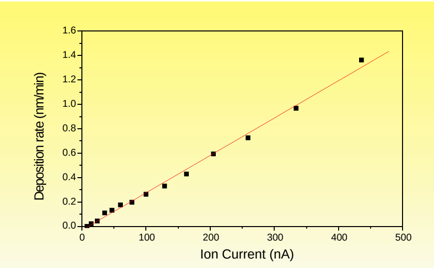
An intrinsic part of the evaporation process results in a small fraction of the vapour being in an ionised state. This phenomenon can be harnessed to determine the deposition rate without recourse to film thickness monitors during evaporation. All evaporators are equipped with flux monitoring plates which not only measure the ion current in the beam, but also act to extract the vast majority of ions, leaving the beam predominantly neutral.

### Uniformity

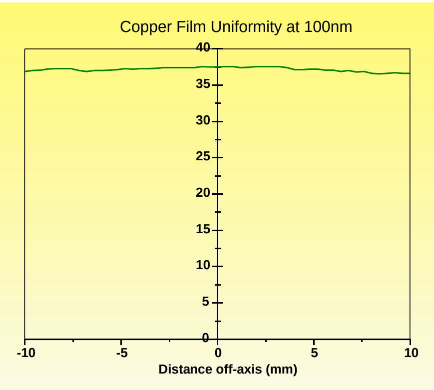
The central deposition profile from the source is essentially identical to the cosine$^2$ distribution from a point source. The deposition from a Ta crucible filled with copper can be seen above right.

# low contamination, low particulate generation and high reliability




*These figures show the relationship between ion current and power (top) and between deposition rate and ion current (bottom) using EGCO4 evaporator. The deposition rate was measured at 100mm from the source exit*




*This figure shows the uniformity of a copper film deposited at 100mm from the exit of the source using an EGCO4 evaporator.*

## Accessories

### *Shutter*

All evaporators can be equipped with an integral shutter. The shutter on the EGCO4 co-evaporation model allows several combinations of pockets to be selectively opened and can also be fitted with a servo-actuator to allow control from the power supply or software (if supplied).

### *Crucibles and liners*

The evaporators can be fitted interchangeably with crucibles or rods. Crucibles are suitable for use with insulators, materials which require an evaporation temperature

significantly higher than the melting point or which have a very high thermal conductivity. Liners should be used where metals are prone to alloying.

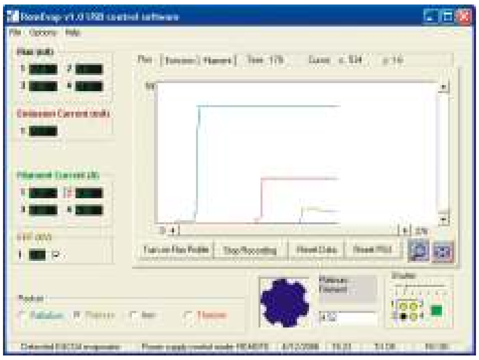
Crucible materials: W, Mo, Ta, C
Liner materials: C, PBN, $Al_2O_3$

### *Software control (EGCO4 only)*

Optional hardware additions to the power supply allow control from Windows™-based software. The software package allows control of key parameters inherent to the operation, as well as simulating control of indirectly affected parameters such as flux. This greatly simplifies practical operation for the user. The latest generation of software communicates with the power supply with a standard USB (Universal Serial Bus) interface.

The software allows:

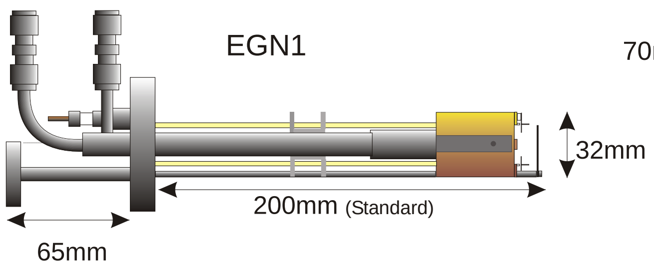
- Real-time flux control and adjustment
- Data logging on screen and to a file
- Graphical or text-based programming of flux profiles. The flux can be programmed to follow a series of polynomial curves over extended periods up to 24 hours
- Shutter control (with optional servo-actuator).

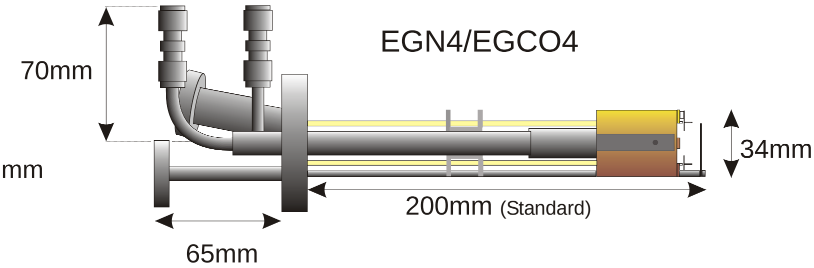


### *Hardware flux control (EGN1 and EGN4 only)*

The evaporator power supplies can be externally or internally controlled by optional hardware designed to maintain a constant deposition rate. The flux controller hardware uses the ion current measured with the flux monitoring plates in a feedback loop to regulate the power applied to the evaporant.

## Dimensions and Specifications




*All evaporators are manufactured to a standard length of 200mm. At customer request this length can be modified to be between 150mm and 400mm. Please note that the diagrams are for illustrative purposes only and are not to scale.*

| Model | EGN1 | EGN4 | EGCO4 |
|---|---|---|---|
| Pockets | 1 | 4 | 4 |
| Co-evaporation | No | No | Yes |
| Mounting flange | NW35CF (70mm / 2.75”) | NW35CF (70mm / 2.75”) | NW35CF (70mm 1/ 2.75”) |
| e-beam power | 200W | 200W | 200W |
| Water cooling | Yes | Yes | Yes |
| In-vacuum length (standard) | 200mm | 200mm | 200mm |
| In-vacuum diameter | 32mm | 34mm | 34mm |


**Oxford Applied Research Ltd.**
e-mail sales@oaresearch.co.uk
Tel +44 (0)1993 773575
Fax +44 (0)1993 702326

**Oxford Applied Research USA**
e-mail oarusa@optonline.net
Tel 845 398 1962
Fax 845 398 1963

OXFORD APPLIED RESEARCH
Crawley Mill, Witney
Oxfordshire, OX29 9SP
UK