EVAP-4 Technical Note

Efficient Platinum Evaporation with the Compact Four Pocket Mini E-beam Evaporator (EVAP – 4C)

Platinum, with its high melting point and low deposition rate at elevated temperatures, presents significant challenges in evaporation processes. Achieving consistent and reliable deposition of platinum requires overcoming these inherent difficulties. In this study, several methods were explored for evaporating platinum using the Compact Four Pocket Mini E-beam Evaporator (EVAP – 4C). Among the different approaches tested, the use of carbon support sleeves was found to be the most effective, enabling more efficient and uniform deposition by enhancing thermal management during the evaporation process. This note outlines the experimental setup, the challenges encountered, and the resulting improvements in platinum evaporation achieved with the carbon support sleeves.

Experimental Conditions

The evaporation of platinum was investigated using several different approaches, including evaporation from rod form and crucibles. However, these methods were unsuccessful due to issues such as alloying with the crucible material and the immediate melting of the majority of the platinum in the case of rod evaporation, rather than just the tip. The most effective method was achieved using a carbon support sleeve, as illustrated in the Figure 1 below.

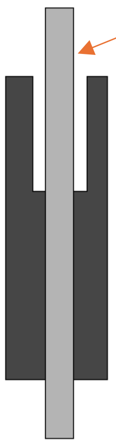

Figure 1: Schematic (not to scale) showing a 2 mm diameter platinum rod (29 mm in length) inserted into a carbon sleeve (5.5 mm diameter, 16.5 mm length). A 3 mm diameter recess is drilled at the top of the sleeve to create a reservoir for the melted platinum.

The carbon support sleeve is a hollow rod that surrounds the platinum rod, with the objective of holding the melted platinum tip near the filament while still allowing the platinum rod to be directly biased. Initially, molybdenum was tested as a support material, but it alloyed with the platinum, resulting in poor performance. Carbon was subsequently chosen as the support sleeve material due to its stability and compatibility with platinum, allowing a reasonable platinum deposition rate to be achieved. This method proved to be the most successful for reliable platinum evaporation.

Results

In Figures 2 and 3, the deposition rate and flux achieved during platinum evaporation using a carbon support sleeve with a platinum rod are presented. The deposition rate was monitored using a quartz crystal microbalance (QCM), which was positioned approximately 120 mm from the evaporation source. The data shows that this configuration allowed for a stable deposition rate, with consistent flux over the course of the evaporation process. The carbon support sleeve effectively maintained the platinum tip near the filament, facilitating efficient melting and vaporization of the platinum while minimizing material loss. The results demonstrate a marked improvement in the evaporation process, with a deposition rate that aligns with expected values for platinum under these experimental conditions.

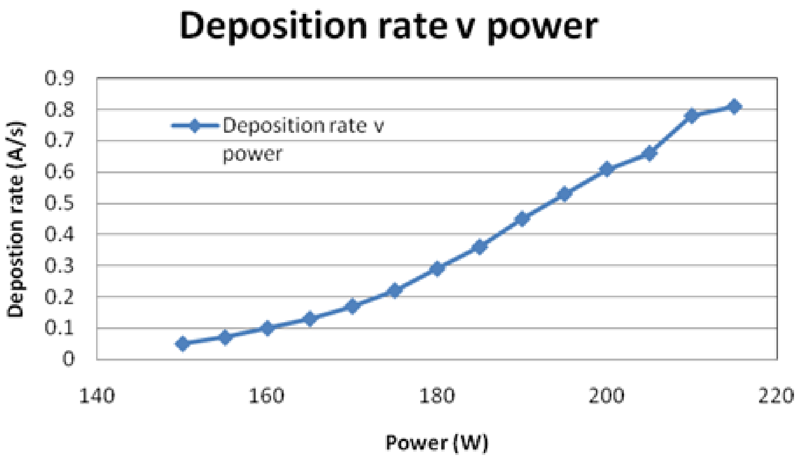

Figure 2: Deposition rate as a function of the power applied to the platinum rod and carbon sleeve combination.

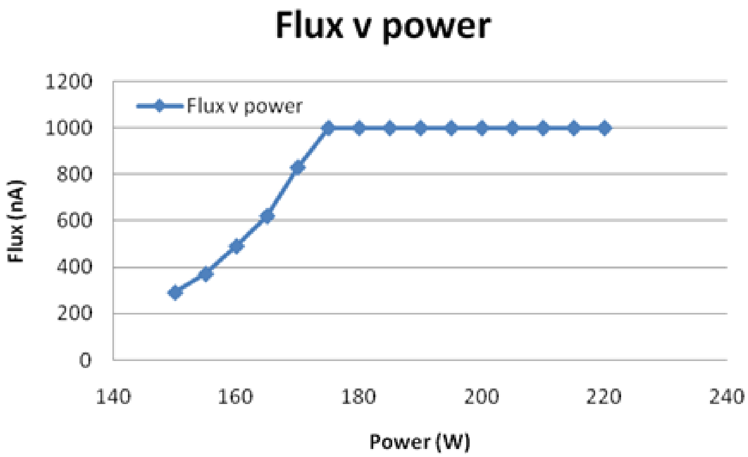

Figure 3: Flux measured using the e-beam source flux monitoring plate as a function of the power applied to the platinum rod and carbon sleeve combination.

The experimental setup demonstrated consistent performance at a deposition rate of 0.2 A/s, where the flux remained stable, allowing for controlled and reliable platinum deposition. As power was gradually increased, the system efficiently transitioned into higher deposition rates without significant issues, and the onset of spitting subsided after a brief period, providing a stable process for the user. This flexibility allows for further power increases, facilitating the achievement of a useful deposition rate for various applications. The process showed promising results at moderate power levels, maintaining a stable and reproducible deposition environment.

Conclusion

The use of a carbon support sleeve for platinum evaporation in the Compact Four Pocket Mini E-beam Evaporator (EVAP – 4C) has proven to be an effective method for achieving stable and reliable deposition. The experimental results demonstrate that this approach mitigates the challenges associated with alloying and material loss, commonly encountered when using alternative support materials. The deposition rate was successfully controlled at a stable 0.2 A/s, with the system maintaining flux consistency over the evaporation process. While achieving deposition rates above 0.7 A/s proved impractical due to the evaporation of the carbon sleeve at higher power levels, the method allows for a flexible and reproducible process at moderate rates, making it suitable for applications requiring precise platinum thin films.