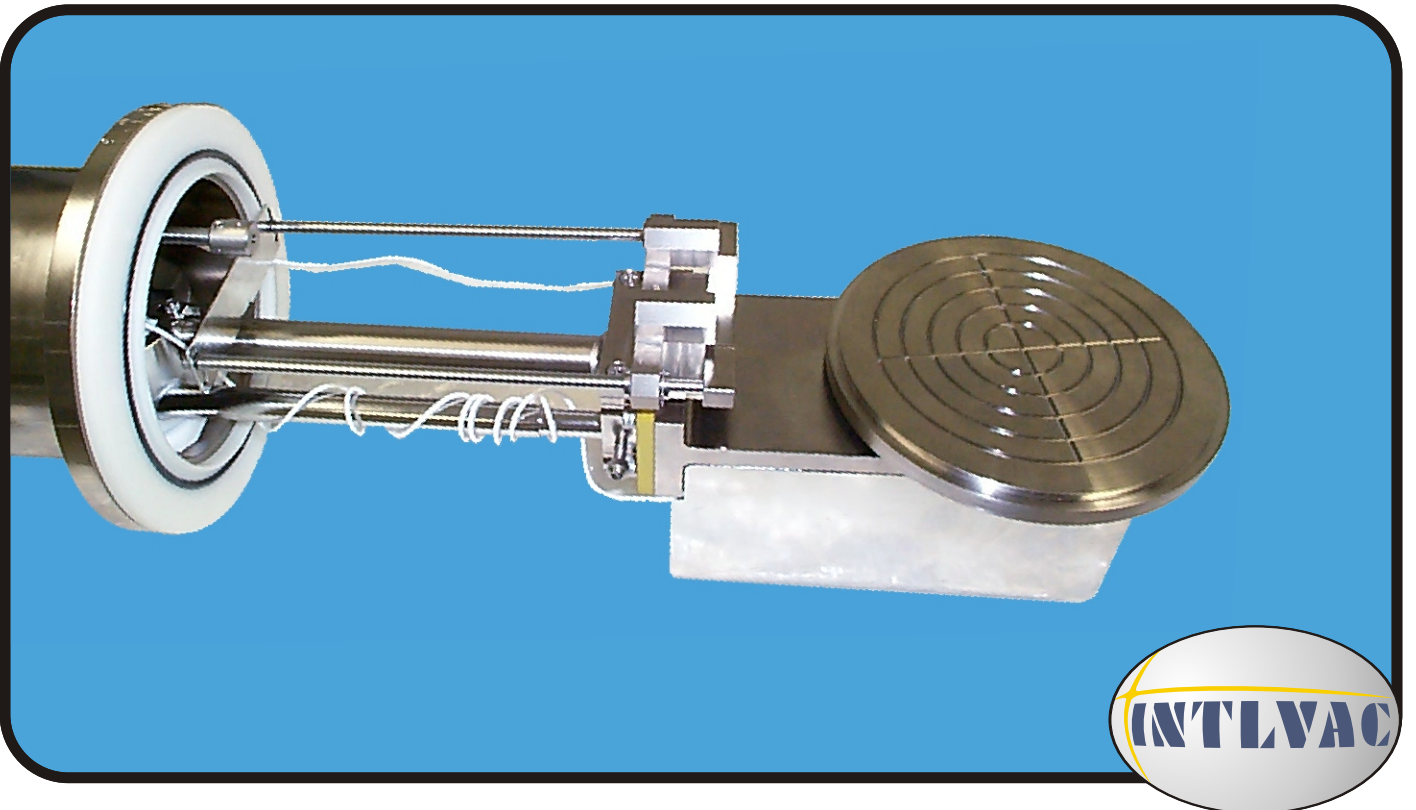


High Vacuum Substrate Stage

Characterization of **Inlvac's**
High Vacuum Substrate Stage



Intlvac's high vacuum substrate stage is designed for deposition and etching of optical, electrical, and magnetic thin films using temperature sensitive processes. It can be mounted in a high vacuum chamber and is able to control the temperature of a substrate during operation

In order to characterize the properties of the substrate stage, it was mounted in an Intlvac Nanoquest system equipped with an 8 cm gridded DC ion beam source.

Calibration of the Substrate Stage Temperature using a Nanoquest System

The experimental parameters are as follows:

- ◆ Stage was not rotated during measurements
- ◆ K-type thermocouple was bonded to the Si substrate using thermal paste. The substrate was then "drichuked" for 15 minutes.
- ◆ Glycol-water was used as the cooling liquid; flow rate: 3 L/min.
- ◆ UHP Argon was used as process gas; flow rate: 10 sccm.
- ◆ Process pressure: 2.4×10^{-4} Torr.
- ◆ Ion beam source: 8 cm, DC gridded, defocused
- ◆ Distance from source to substrate was 25.4cm. Angle of incidence: 90°

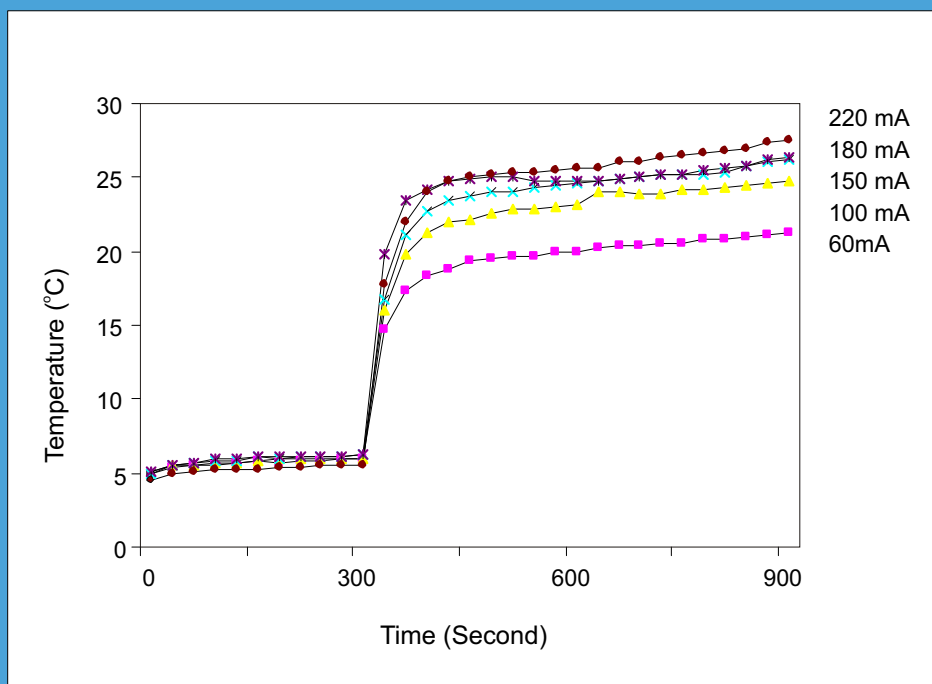


Fig.1 Temperature dependence of a Si substrate on the cooling stage for an ion beam voltage of 500 V. The ion beam currents used were 60, 100, 150, 180 and 220 mA. The ion beam was ignited after 300 seconds. The steady-state temperature of the stage prior to ignition was about 5°C

During the experiment, a water cooled chiller system (Bay Voltex Corporation, RRS-2450-WC-FS) was applied to re-circulate cooled glycol-water. Coolant was supplied to the stage through two 4-meter long plastic tubes. For each set of measurements, the stage temperature was first stabilized at 5°C and then 10°C after 1 hour of operation.

The graph above (Fig.1) shows curves of temperature versus length of ion beam source operation for an initial steady-state temperature of 5°C. The process pressure was roughly 2.4×10^{-4} Torr. It can be observed in Fig.1 that the substrate temperature increased from the steady state temperature of 5°C to about 25°C as soon as the ion beam source was ignited.

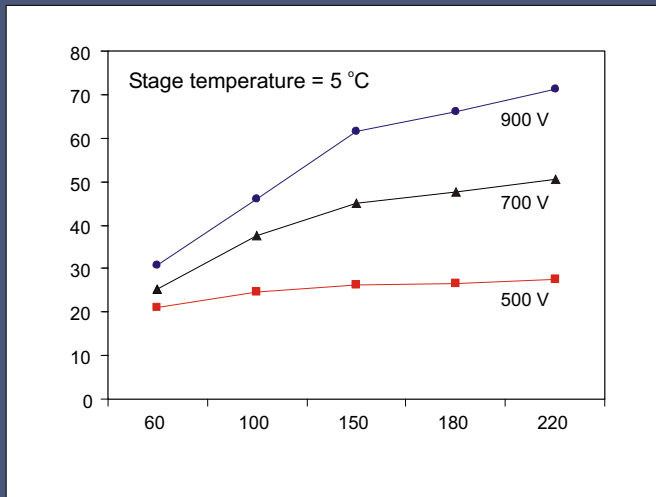


Fig.2 Beam current vs temperature at different voltage for an initial steady state temperature of 5°C. The temperature was recorded 15 minutes after the ion beam source was turned on.

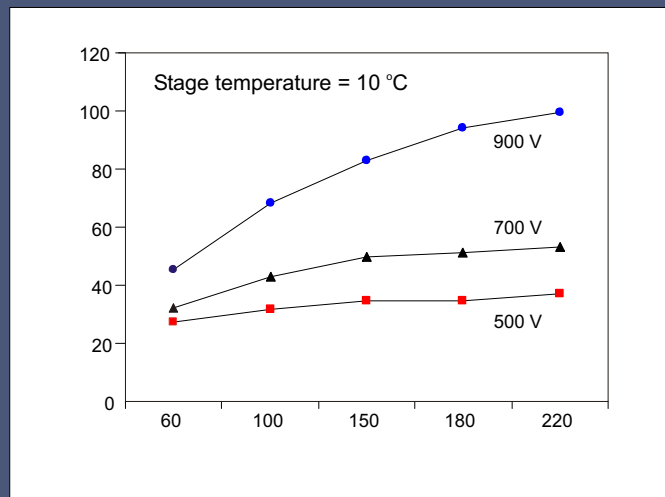


Fig.3 Beam current vs temperature at different voltage initial steady-state temperature of 10°C. The temperature was recorded 15 minutes after the ion beam source was turned on.

The substrate temperature was measured as a function of beam current for voltages of 500V, 700V, and 900V. The beam currents used at each voltage were 60mA, 100mA, 150mA, 180mA, and 220mA. The substrate temperature after 15 minutes is summarized in Fig 2 and Fig.3 for stage set points of 5°C and 10°C.

The highest recorded temperature of the silicon substrate for an initial steady-state stage temperature of 5°C and 10°C was 71°C and 99°C respectively. This occurred in both cases for a beam voltage of 900V and beam current of 220 mA.

Intlvac DRICHUK design has the best thermal conductivity

Research was carried out to compare our thermally conductive elastomer pad (DRICHUK[†]) with other materials such as Mung I and Apiezon vacuum greases*. The steady-state temperature prior to the run and the beam voltage were 5°C and 700V respectively.

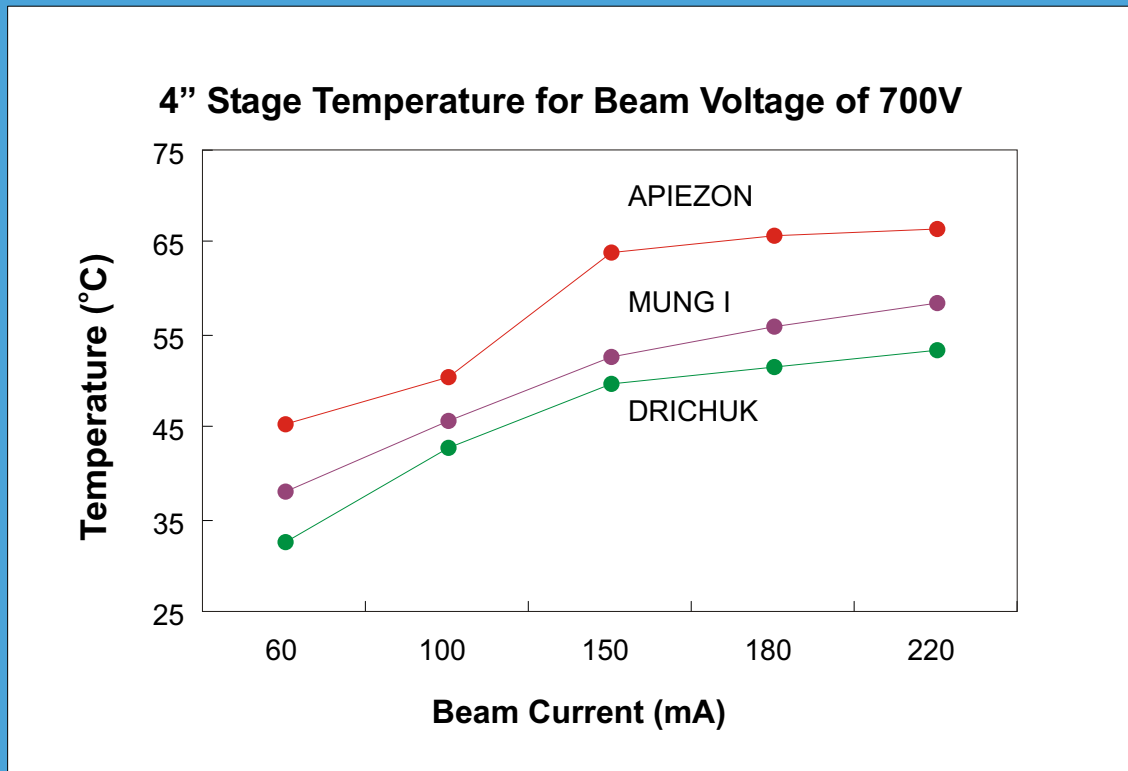


Fig. 4 Temperature comparison of thermal conductive materials between stage plate and Si substrate

Fig. 4 shows the substrate temperature after the ion beam source had been turned on for 15 minutes with a beam voltage of 700 V. It can be seen that the temperature increases somewhat linearly from 25°C to 50°C with increasing beam current from 60 to 220 mA for DRICHUK. A similar trend can be observed for Mung I and Apiezon. However, DRICHUK was able to keep the substrate cooler and DRICHUK avoids the possibility of contamination from hydrocarbons and other materials such as ones found in Mung I and Apiezon

* Mung I and Apiezon vacuum greases are hydrocarbon based adhesive greases

[†] Drichuk vacuum pads are made of a silicon elastomer matrix embedded with silver powder



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