Heavy Ion Induced Desorption

Measurements on Cryogenic Targets

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Heavy Ion Induced Desorption

- Collisions with residual gas particles cause charge exchange of beam ions.
- These ions deviate from their projected paths and collide with the wall.
- Previously adsorbed gas particles are released, pressure rises.
- Self-amplifying process resulting in beam loss → Beam intensity limiting factor.
- Solution: low desorbing surface (ion catcher) at loss positions.
- Ion catcher’s desorption yield critical for accelerator’s maximum beam intensity!

Desorption: Room Temperature vs. Cryogenic Environment

- Room temperature desorption was systematically investigated, optimized material was found[1].
- Room temperature desorption yield scales with the ion’s electronic energy loss at the surface (dE/dx)[1,2].
- SIS100 will feature superconducting magnets → cold walls → bind even more gas → desorption must be suppressed.
- A cryocatcher prototype has been developed and cryogenic desorption was measured.
- New scaling of η at cryogenic temperatures has been found[3].
- Possible explanation: Dependence of η on heat capacity and thermal conductivity.

Experimental Setup and Methodology

- Warm UHV Diagnostics: carries extractor ion pressure gauge and fast residual gas analyzer.
- Differential pumping line and bakeout procedure ensure a sufficiently low pressure to measure a desorption peak.
- A coldhead and a thermal shield provide the cryogenic environment.
- Target assembly equipped with:
  - Temperature sensors – measure thermal reaction.
  - Insulating tile – necessary to measure deposited charge.
  - Ceramic heater – acceleration of warmup.

First Results

- Beamtime with U^{++} and intensities of the order of 10^7 particles per pulse.
- The peak at T=50 K only occurs with rising T. Raw data has been inspected manually in these regions to check for a possible fault in the analyzing algorithm, but none has been found.
- The temperature slope’s direction has a strong influence on the desorption yield.
- Possible explanation: radial T-gradient steeper with activated coldhead → More energy from beam impact dissipates into the inside of the target → Heating the surface above a critical gas release temperature is largely avoided.
- Accuracy of measurement visible in point scattering at T_{exp}.
- The falling T-slope is steeper than the rising one, so data is less abundant in the cooldown cycle.

Desorption Yield:

$$\eta = \frac{N_{des}}{N_{beam}} = \frac{\Delta p \cdot V}{N_{beam} \cdot k_B T}$$

Outlook

- Another target made of stainless steel is already prepared. Its heat capacity is comparable to copper, while its thermal conductivity is lower.
- This target is uncoated, so the coating’s influence will also be investigated.
- The current insulation tile is made of Al^3, while its thermal conductivity is lower.
- Another target made of stainless steel is already prepared. Its heat capacity is comparable to copper, while its thermal conductivity is lower.
- The influence of the T-slopes direction will be further examined by conducting two measurements which are identical except for the T-slope.
- Different ion species will be used and their influence will be analyzed.

References:


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