Progress with Laser Ablation Surface Engineering (LASE) and NEG Coating studies

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EuroCirCol Task 4.3: Mitigate beam-induced vacuum effects

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4th EuroCirCol meeting, 17-18 October 2018,
KIT, Karlsruhe, Germany
SEY studies
Measurements at room temperature

• Further surface analysis of the >100 samples has been undertaken using surface analysis techniques including:
  • SEM
  • XPS
• SEM was used to look at the surface topography
• XPS was used to measure the surface chemistry
• Results are being analysed
A new cryogenic temperature facility

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RDK-305D 4K Cryocooler (RDK-305D Cold Head with CNA-31C/D Compressor)
A new cryogenic temperature facility

- **Vacuum system:**
  - Assembled and tested

- **Current work:**
  - Electron gun beam alignment
    - Under vacuum,
    - Has started this week
  - Cryocooler testing
    - System pumped,
    - All thermometry attached
    - Awaiting the cable for the compressor to arrive before first test
  - Gas injection
    - To be assembled
  - Gas exhaust
    - In progress
Separating the system into 2

• Separated the system into two independent parts to improve efficiency in commissioning
  • Test the cryogenics and ensure the system cools
  • The electron gun and get the focusing parameters at the required distance
• If one system experiences delays the other can continue to progress
• First test the cold head and thermometry
• Then we will test the full system with the sample holder
• This will be also done to calibrate a second uncalibrated Si diode thermometer (behind the bobbin on Stage 2)
Cryogenics

• We will be using 10 layers of superinsulation as a heat shield
• For the first test it is fitted around the supports, in the full system it will go around the inner vacuum as well
• Ready for a cryogenic test
Electron beam alignment

- Using a phosphor screen for beam profile
- Distance between E-gun and sample is the same as distance to the phosphor screen
- An acceleration greed for low energy electrons
NEG coating studies
NEG coating studies

• Current work:
  • RGA (re-)calibration against extractor gauges
  • More detailed TPMC modelling
    • Studying an effect of RGA position
  • Repeating pumping properties test for columnar Zr film on a sample tubes after 1 year exposure to air
  • Preparing for a cryogenic test with LN2

• Next Steps:
  • Assemble a facility for cryogenic (LN$_2$) measurements and start a cryogenic study
  • Surface characterisation of all samples with XPS, SEM, XRD, etc…
  • Complete the analysis of the data obtained earlier, report to EuroCirCol and publish the results
Modelled pressure ratio vs. sticking probability

- Low accuracy for $\alpha < 3 \times 10^{-3}$
- However in this case:

$$\alpha_M = \frac{S_M}{S_{M,\text{ideal}}} = \frac{4Q_M}{A \overline{V}_M P_M}$$
Tube 1 – dense Zr

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Tube 1 – dense Zr

Tube 1: dense Zr film

Sticking probability vs. Activation temperature, °C

- Red circles: H₂
- Blue triangles: CO

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Tube 2 – dense Zr

![Graph showing sticking probability vs activation temperature for H2, CO, and CO2 in a dense Zr film.](image)
Tube 3 – columnar Zr
Tube 3 – columnar Zr

- Initially
- After 1-year exposure to air
Comparison of columnar and dense Zr films
Cryogenics

- All parts required to assemble the system + insulation materials have been received
- Silicon diode thermometers to be attached
- Needs to be tested with LN$_2$ flow to see what the lowest temperature can be achieved:
  - Without a heat
  - With a heat load during equal to one at the ESD measurements