
# 3. Novalis Meeting – Update BUW

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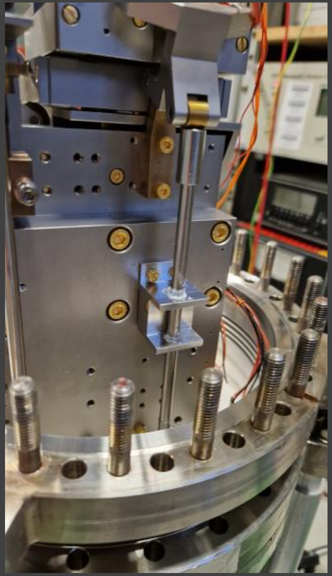
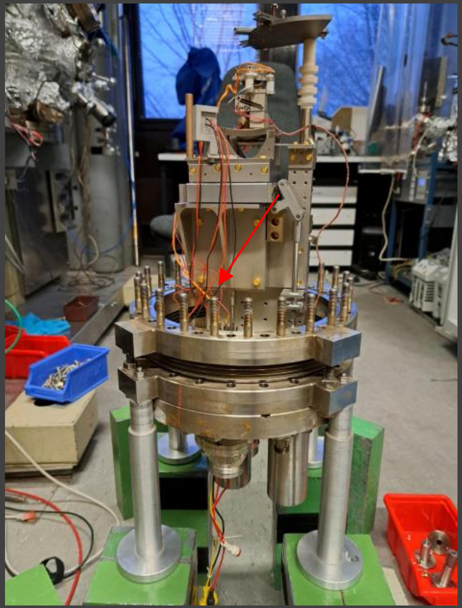
# FESM - Status

- Repair of the XYZ-Stage
  - Rods for X- and Y-axis had mechanical play in linear guides

  → New linear guides fixed the problem
- Baked out at 120 °C
  - Pressure in main chamber: $8 \cdot 10^{-10}$ mbar

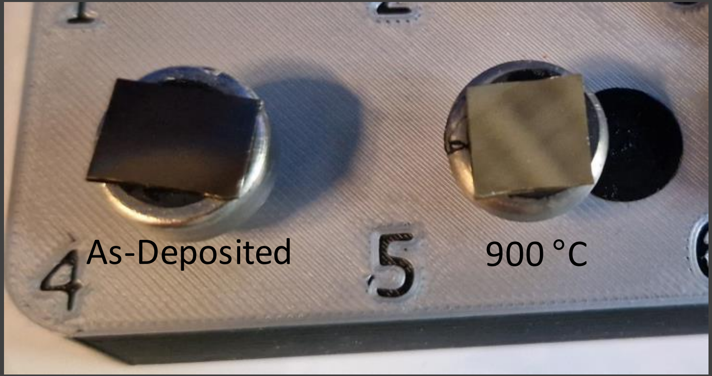
→ FESM fully operational again





# New NbTiN samples

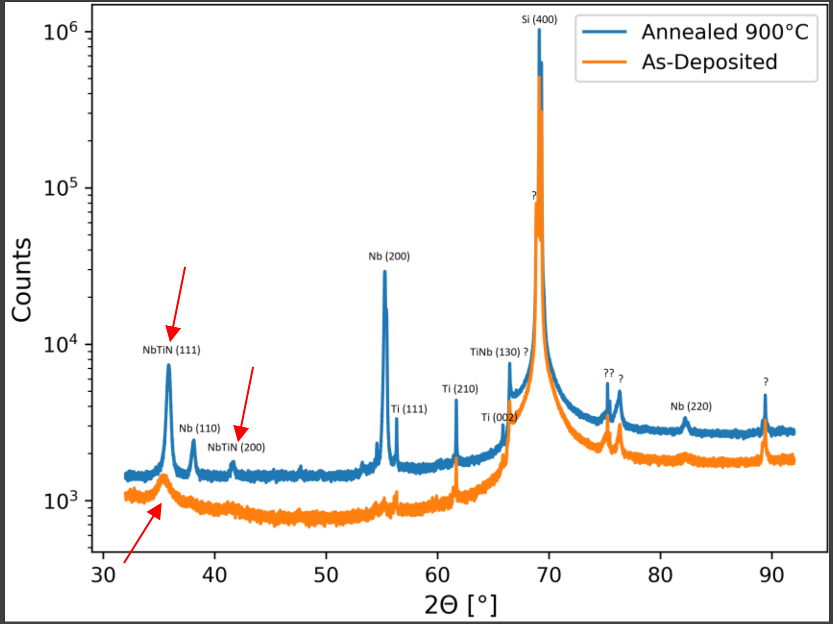
- Two NbTiN samples from Marc, Lea and Isabel
  - 60 nm NbTiN + 15 nm AlN on Si-Wafer
  - Both as-deposited and annealed at 900 °C
- Planned analysis:
  - XRD (first results)
  - OP / AFM (first results)
  - SEM
  - FESM



# XRD - Influence of annealing NbTiN

- NbTiN (111)-Peak shifts to larger angle
  - $Nb_{1-x}Ti_xN$ recombinating to larger x
  - Could partly explain creation of Nb phases
- Sharper NbTiN (111)-Peak indicates growth in grain size

  → $L_{ad,111} = (67.60 \pm 49.17)$ Å to $L_{900\,°C,(111)} = (268.96 \pm 1.80)$ Å
- Growths of NbTiN (200)-Phase
  - $L_{900°C,(200)} = (269.82 \pm 17.69)$ Å

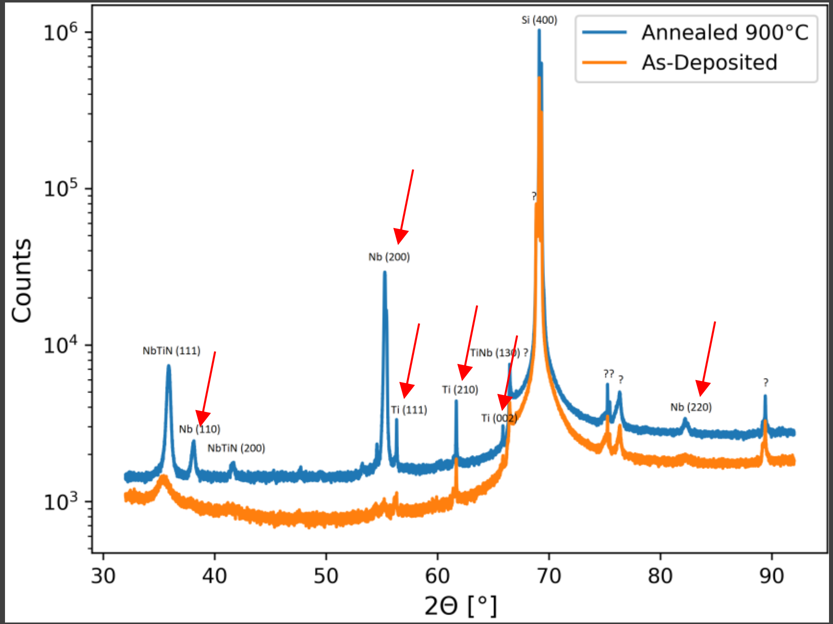


# XRD - Influence of annealing NbTiN

- Annealing leads to creation of elemental Nb-phases
- Both Ti- and Nb-peaks increase

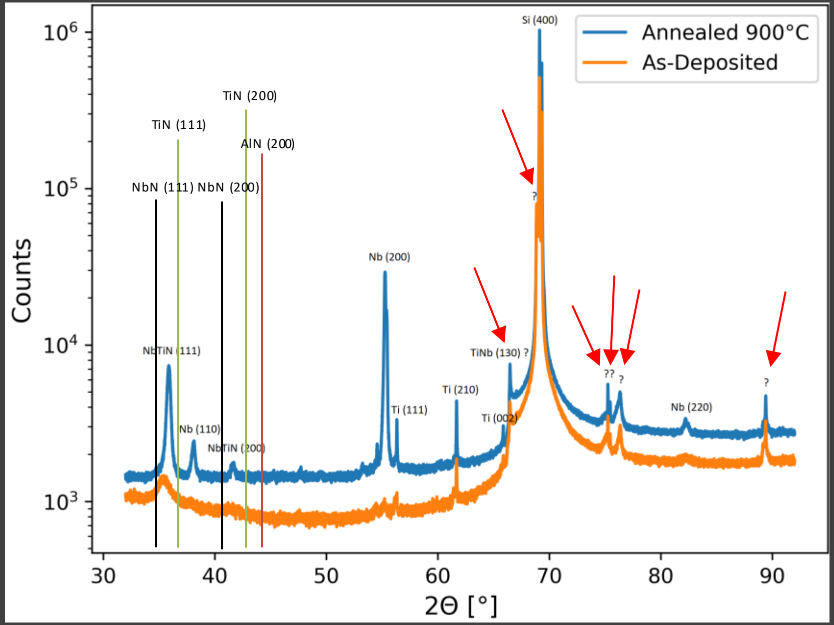
→ Decomposition of NbTiN to Nb and Ti

→ Annealing under nitrogen atmosphere could slow down decomposition process



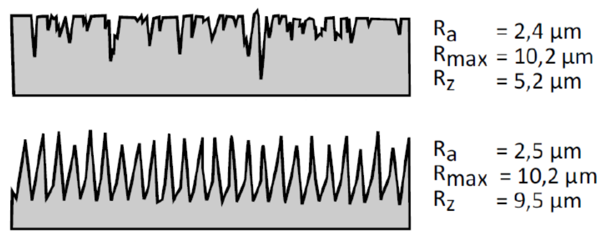
# XRD - Influence of annealing NbTiN

- Few unknown Peaks
  - AlN layer is too thin
  - Annealing should show changes in oxide phases
  - no TiN or NbN phases
- Grazing incidence XRD could show in which depth unkown structures are
- Potential TiNb (130) -peak at (66.47 ± 0.01) °
  - Theoretical angle at 66.821 °
  - → 0.45 % bigger lattice parameter due to stress
  - → Annealing does not reduce stress



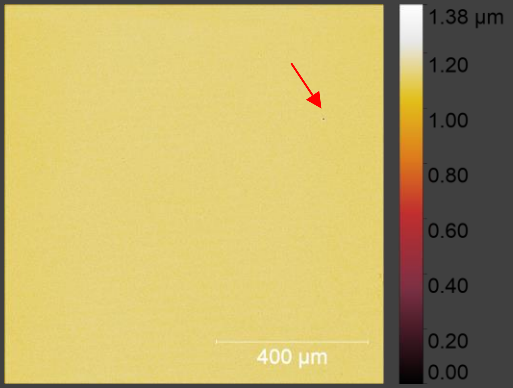
# Optical profilometer

- White light irradiation and spectral reflection
  - Chromatic aberration
- Scanning range up to 20 x 20 $cm^2$
- 2 µm lateral resolution
- 3 nm vertical resolution
- For higher resolution the AFM can be used



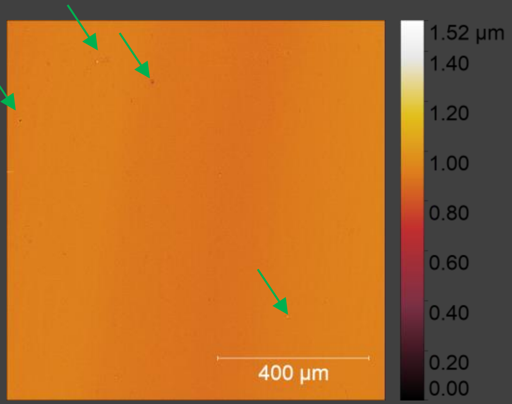

- FE sensitive to peaks on the surface
  → $R_z$ relevant for determining the surface roughness for FE applications
- $R_z$ is the maximum peak to valley height

# OP – Surface roughness of NbTiN thin films



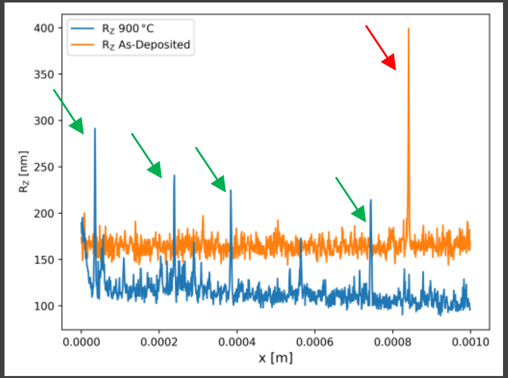

As-deposited
- $R_a$ = (23.80 ± 0.62) nm
- $R_z$ = (165.50 ± 12.51) nm

over 10 x 10 mm²




Annealed 900 °C
- $R_a$ = (16.13 ± 1.01) nm
- $R_z$ = (116.30 ± 18.25) nm

over 10 x 10 mm²




- Particles or defects on surface yield high $R_{z,i}$ values
- Does not influence overall $R_z$ too much

→ Annealing reduces $R_a$ by 32.22 % and $R_z$ by 29.73 %

# Summary and Outlook

- Grain size of NbTiN significantly increases due to annealing
- Surface roughness reduced by ≈ 30 %
  → Smaller surface peaks increases onset-field of FE
- XRD data shows decompositon of NbTiN due to annealing
  - Annealing under nitrogen atmosphere could slow down the process

- Looking forward to:
  - FESM measurements
    - I-V-curves
    - Constant current mapping
  - SEM and EDX measurements
  - Further analysis on XRD and OP data

# Thank you for your attention!