Ion beam analysis of tokamak samples and implantation capabilities of reference samples

SP WP PWIE SP B.2 & SP B.3: Kick-off meeting, 9 March 2023

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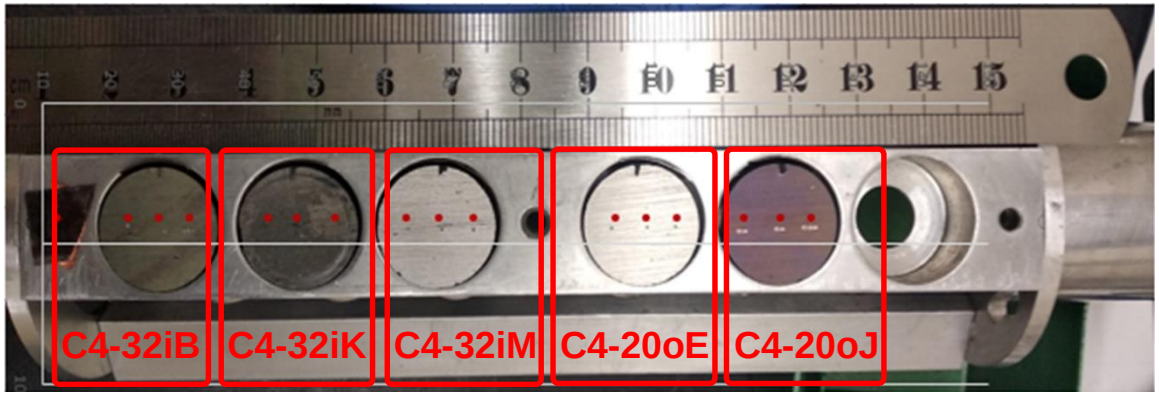
SP B.3 Characterization of plasma-exposed materials
C3 - C4 WEST Tiles



NRA and SIMS comparison

Analysed points:
- **IBA at IST**
- **SIMS at VTT**

RBS / NRA - 2300 keV $^{3}He^{+}$ beam
EBS / PIXE - 2300 keV $^{1}H^{+}$ beam

Typically, elemental amounts quantified for D, B and C, and for W (w within the marker layer), followed previously quantified amounts *(IPP, see in M. Balden et al., Phys. Scr. 96 (2021) 124020)*

Cr, Fe and Cu identified as heavier impurities by PIXE

SP B.4 Reference coatings for ITER and DEMO

9 Be-D, Be-O-D coatings produced at IAP
D amounts decrease by increasing Deposition Temperature (from RT to 400 °C)

14 W, W-(He,O,Ne), W-(He,O,Ne)-D based coatings produced at IAP

4 W-O, W-N, W-N-O coatings produced at ENEA

Study of retention properties by implantation of reference samples

ROOM TEMPERATURE – ION IMPLANTATION EXAMPLES

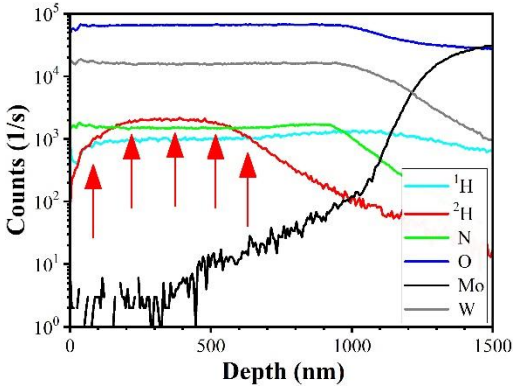
- **Sequential implantation stages of $^4He^+$ or of $^2H_2^+$ in W coatings**

Flat Profile for implanted element

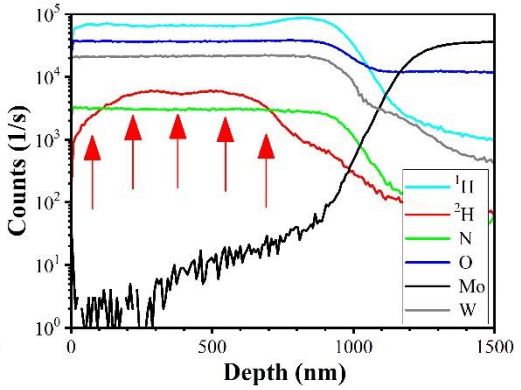
Case of $^2H_2^+$ implantation
150 keV / 2x10^{17} ion/cm^2
100 keV / 2x10^{17} ion/cm^2
50 keV / 1x10^{17} ion/cm^2

WFW600 / ~1 μm porous W-O on Mo
WFW624 / ~1 μm porous W-N-O on Mo

SIMS / WFW600 + ^2H

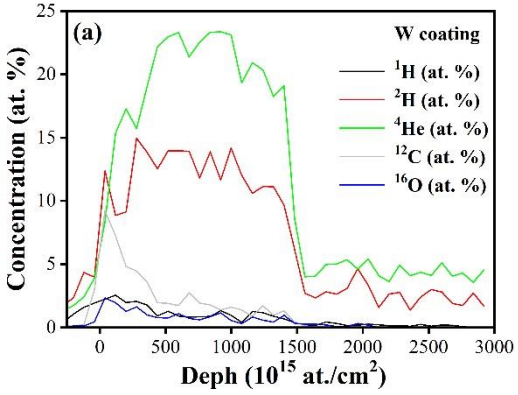


SIMS / WFW624 + ^2H

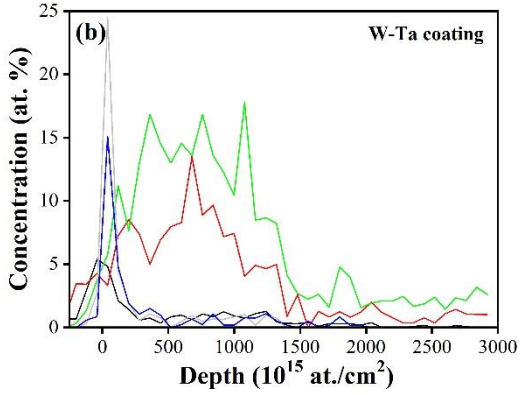


- **Irradiation of W , W-5%Ta coatings / 30 keV $^4He^+$ - 30 keV $^2H_2^+$ - 5 x 10^{17} ion/cm^2**

ToF-ERDA / W + ^4He + ^2H



ToF-ERDA / W-Ta + ^4He + ^2H



lower ^4He, ^2H retained amounts in W-Ta than in W

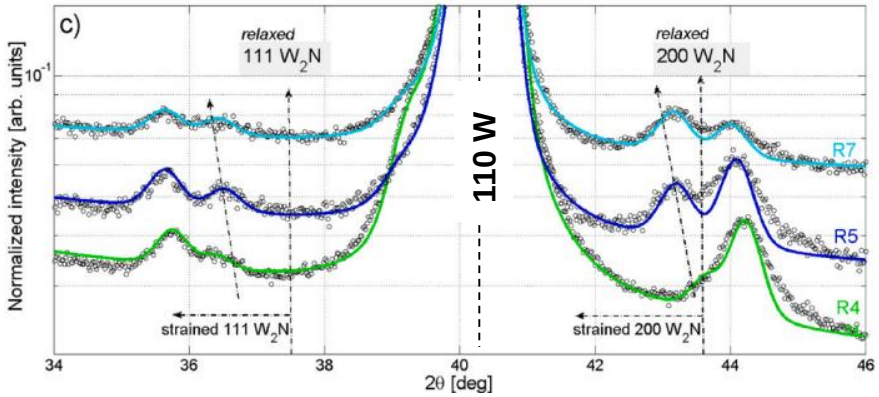
Planning 2023 activities

- Proceed with the analysis of exposed WEST tiles (C5 WEST campaign)
- Analysis of reference samples irradiated at MAGNUM-PSI, PSI-2, GyM
- Implantation of He and D loads in reference coatings with energetic ions
  - Single implantations
  - Sequential implantation stages at distinct energies/fluences
- Other irradiations may be performed with reference coatings
  - Retention studies
  - Phase formation

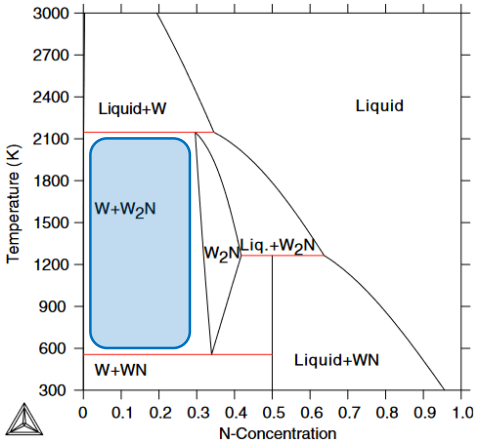
Implantation capabilities of reference samples (example)

- 60 keV N_2^+ implantation in W coatings / formation of the β-W_2N phase

XRD / W + N



from bcc W to fcc β-W_2N



[K. Schmid et al. NF 50 (2010) 025006]