IPPLM activities in 2022: Electron microscopy of JET PFCs – plans and capabilities

Elżbieta Fortuna-Zaleśna, WUT

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Outline

- Main research areas in FP8
- WUT microscopy and analytical equipment, examples of its use in the former WPJET2
- Plans for 2022/2023

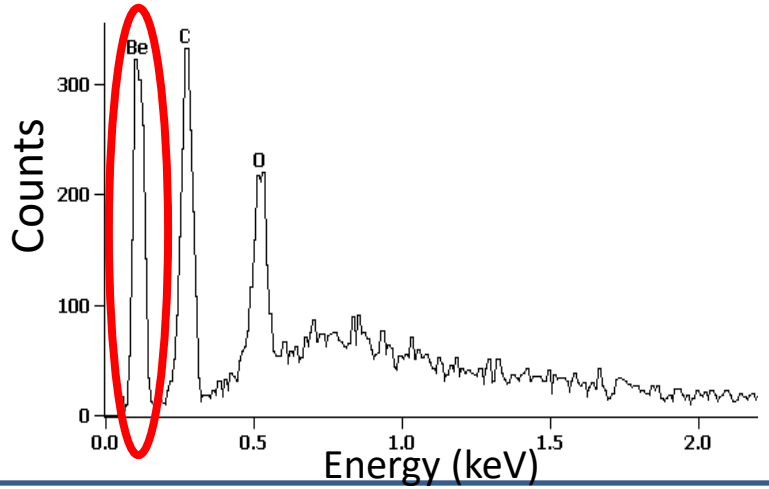
Main research areas in FP8

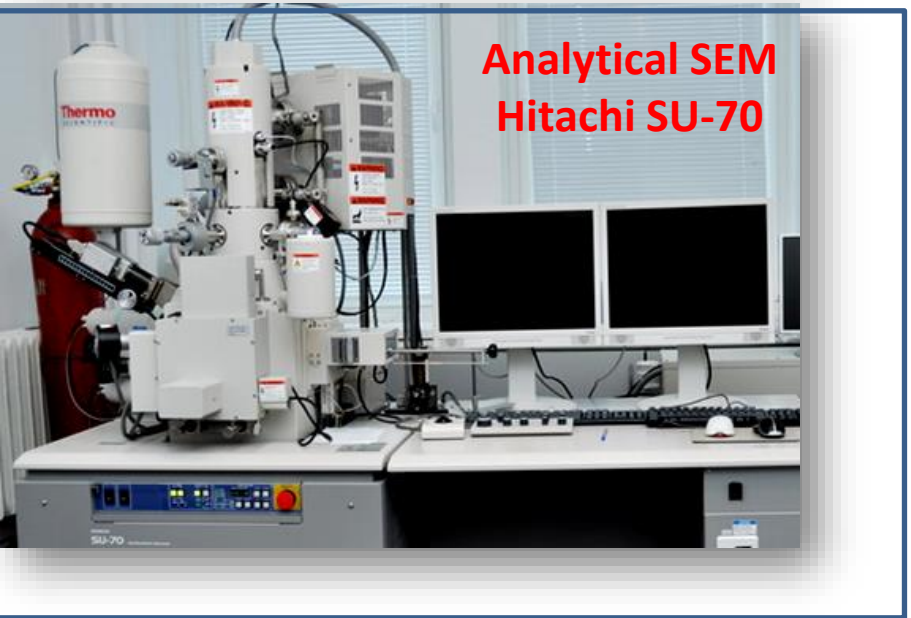
- *Microscopy of mirrors* from cassettes on the main wall and from the divertor, both ILW-2 and ILW-3.
- *Dust examinatios*: (i) from Si collectors ILW-2 and ILW-3, (ii) collected on sticky pads from the divertor tiles and Be IWGL, (iii) dust retrieved from JET by vacuum cleaning and (iv) from the robotic arm and on the multifunctional robot (equipment for remote handling).
- Microscopy of 2015-2016 spatial blocks, QMB covers, W-CFC core samples, filters etc.
- *Nanoindantation (nano mechanical properties) of bulk W samples* (Langmuir probes).

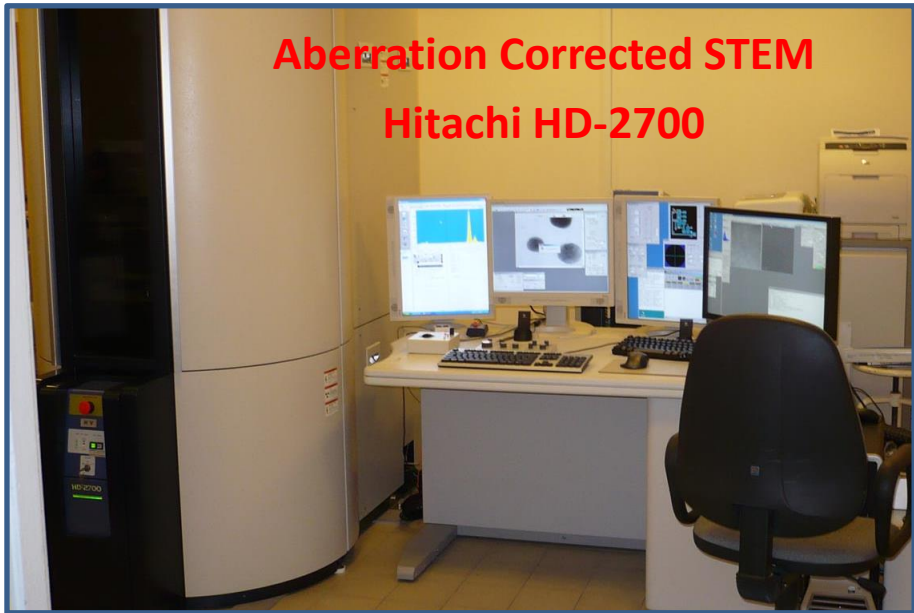
WUT equipment

Be detection with SEM Hitachi SU-8000

EDS Thermo Scientific Ultra Dry, type SDD







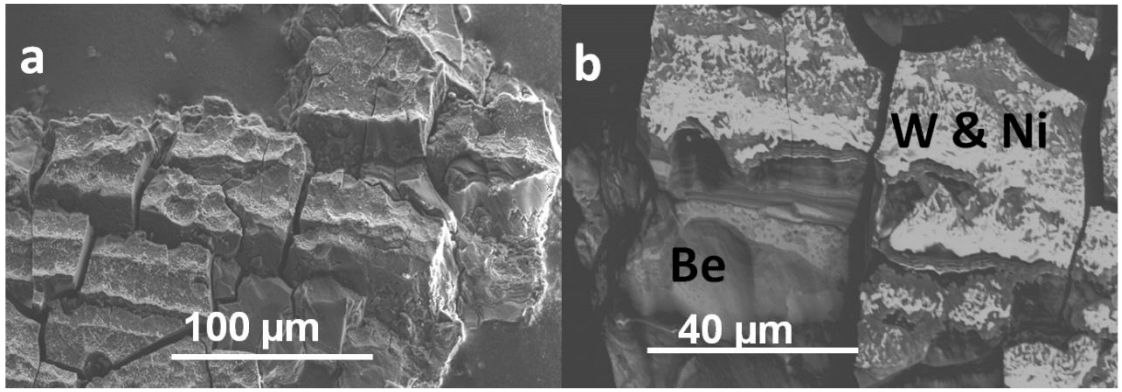
List of microscopes

- **HD-2700 STEM (200 kV, C_s corrected) – High resolution, analytical, dedicated STEM, in-situ nanoindentation**
- **JEM1200 TEM (120 kV) – Conventional TEM, in-situ heating, straining**
- **S-5500 FE-SEM - High Resolution SEM, Low accelerating voltage S(T)EM**
- **SU-70 FE-SEM – Analytical SEM**
- **SU-8000 FE-SEM - Low accelerating voltage SEM**
- **S-3500N SEM – Low vacuum observations, in-situ tensile test**
- **TM-1000 SEM – Table top microscope**
- **TM-3000 SEM – Table top microscope**
- **FB-2100 FIB – Single beam scanning ion microscope**
- **NB 5000 FIB-SEM – Dual beam scanning microscope**
- **Other equipment for sample preparation etc.**

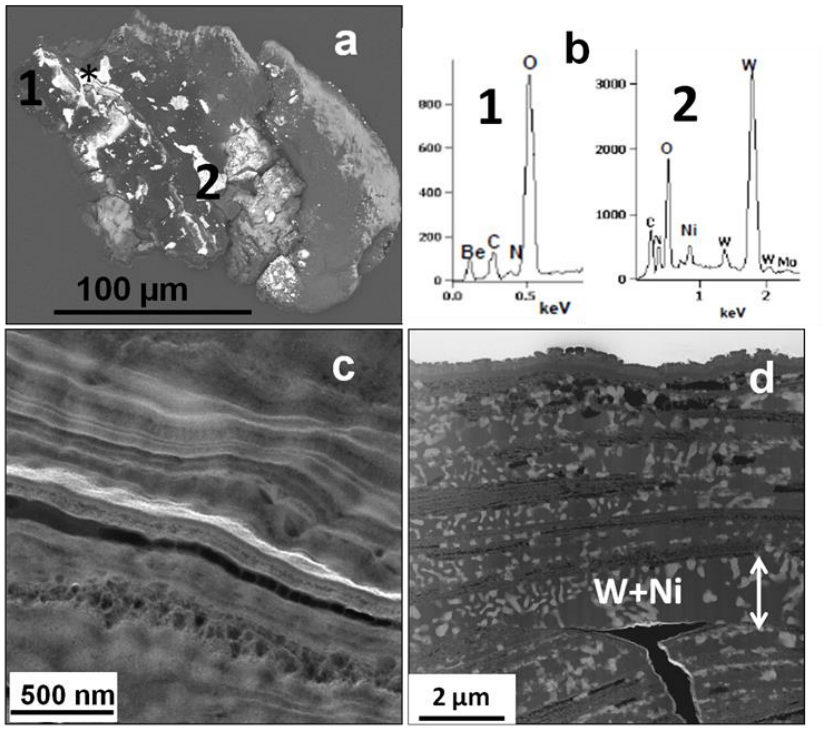
Other equipment

- **XRD, Bruker D8 Discover X-ray diffractometer**
- **Optical profilometer Veeco NT9300 for non-contact 3-D measurements of surface topography**
- **Hysitron Ti-900 triboindenter (Young's modulus, hardness, in situ SPM)**

Dust collected by sticky pads



Thick co-deposits collected from Tile 0 after ILW-2.



Deposits on apron of Tile 1 after ILW-2 campaign (a) a typical dust/co-deposit particle, (b) EDX spectra from two regions, (c) stratified Be-rich deposit, lamella cut from the region indicated as 1 (d) mixed deposit with light and heavy elements, lamella cut from the region indicated with asterisk. The white double side arrow in Fig. d indicate the sublayer rich in W and Ni.

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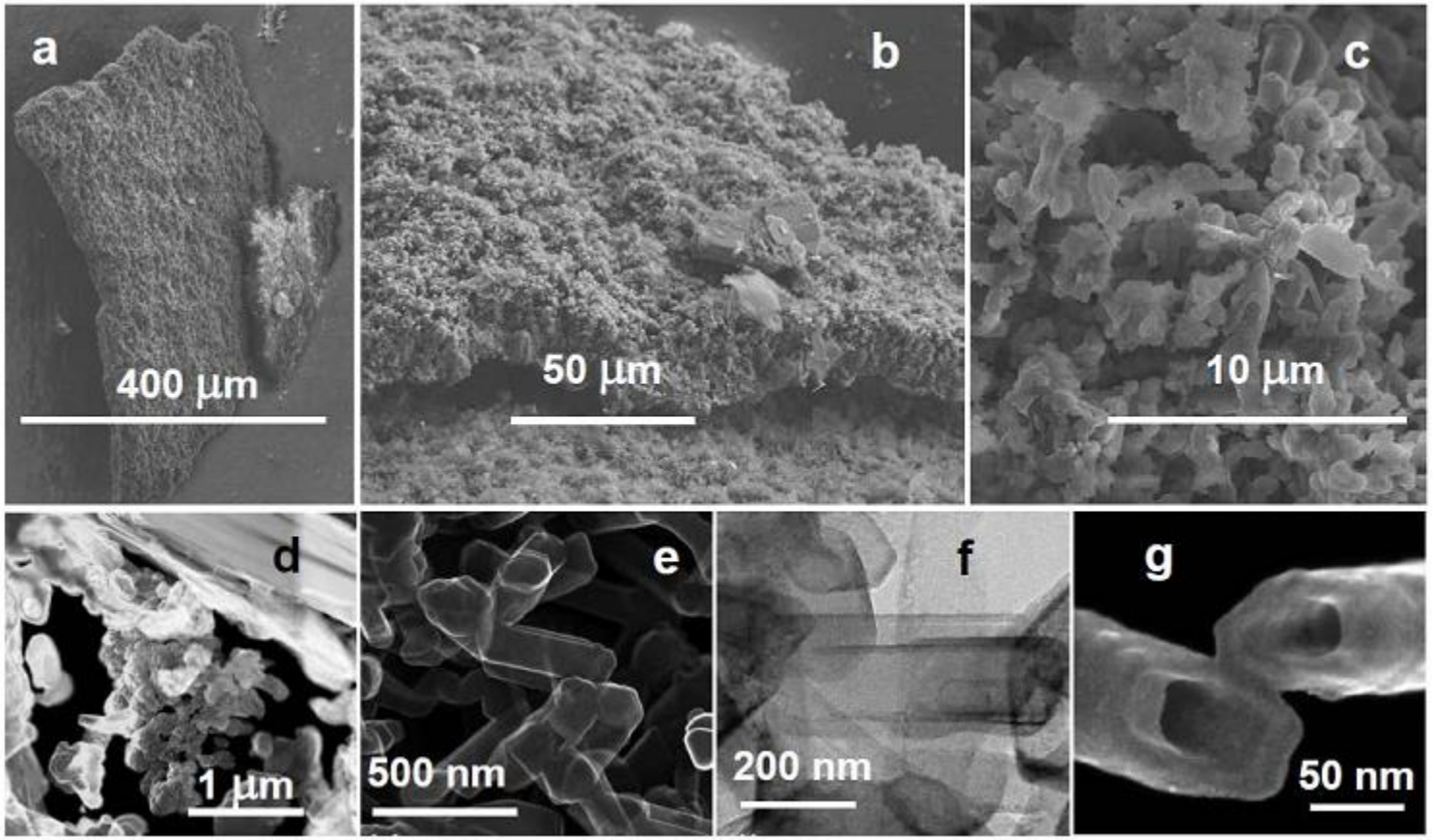
Dust collected by sticky pads



Be-rich co-deposits on the divertor carrier under Tile 6 after ILW-2,(a)–(c) surface topography (SEM) and (d)-(g) internal structure recorded (STEM).

- ✓ The place of collection indicates that they come from deposits accumulated on the diverotr plates,
- ✓ The large size and high porosity (> 300 µm and> 30 µm thickness) may partly explain the very low weight of the matter collected by vacuuming.

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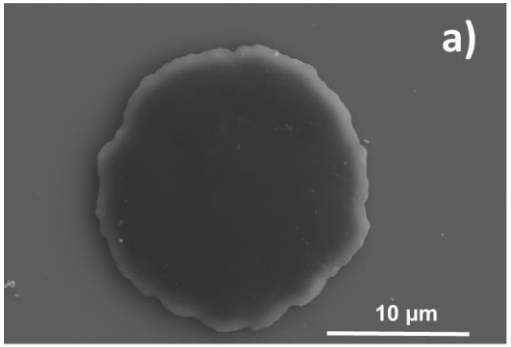
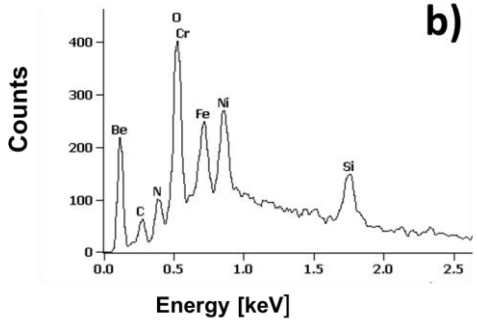
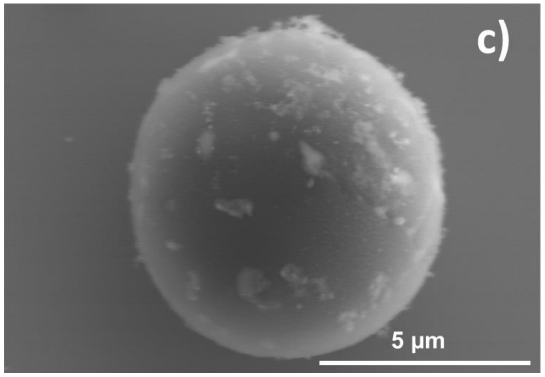
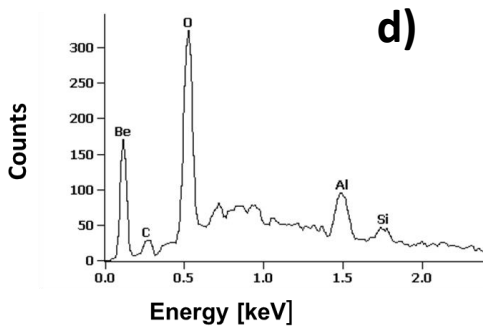
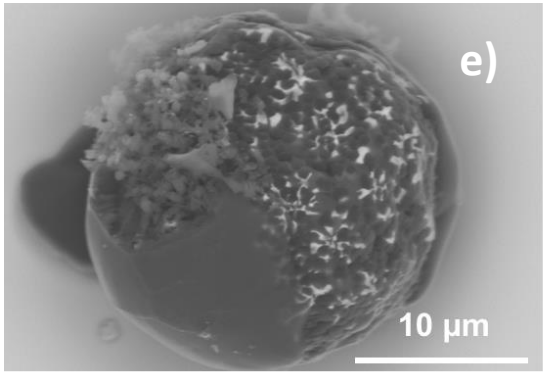
Be dust particles from Si dust collectors

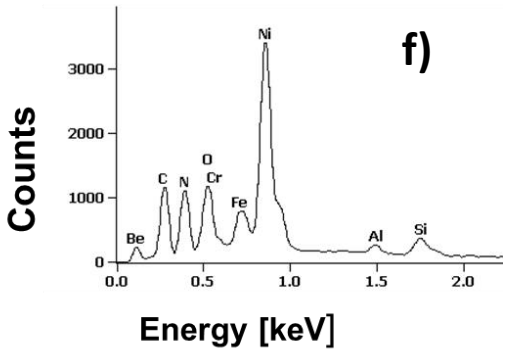








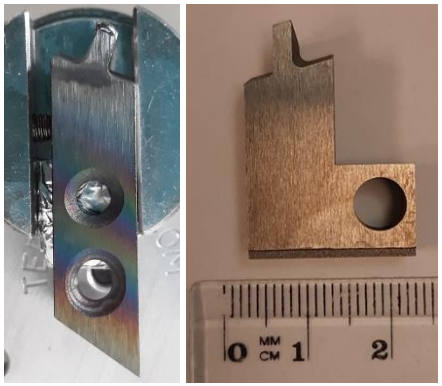




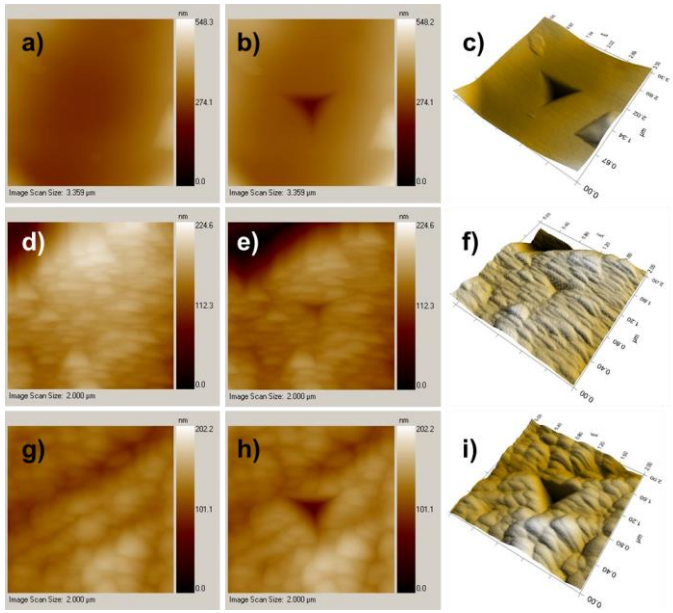
Phys. Scr. 170 (2017) 014038
Nucl. Mater. Energy 27 (2021) 100994
Phys. Scr. 96 (2021) 124038

(a) Be splash, IN4-ILW-2 and (b) Be spherical particle, OU2-ILW-2, c) spherical beryllium co-deposits OU6-ILW-3

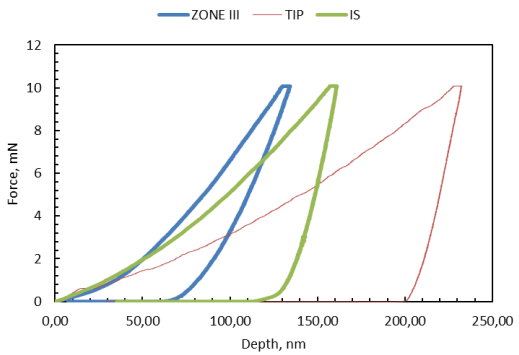
Nanomechanical properties



Langmuir probes



SPM images of the probe surface before the measurement and of the imprint made on the recorded area, for the tip (a-c) and support structure (d-f) of LP-5 and for the surface of the not exposed probe.



Force-depth curves for all examined zones

Phys. Scr. 96 (2021) 124072, First report on mechanical properties of JET plasma-facing components determined by means of NIT.

Plans for 2022

SP E.3 task description: *Electron microscopy (SEM, TEM, FIB) of JET plasma facing components.*

Techniques available: SEM (with EDS enabling Be detection), TEM, FIB, XRD, optical profilometry, nanoindentation.

At present we have no JET samples in our laboratory. We will study the samples that will be delivered to us for examination (Langmuir probes as well as others provided for us).