National Institute for Laser, Plasma and Radiation Physics

XRF measurements: surface structure and microscale compositions

Report microstructural integrity and W thickness measurements conducted on: C3-220M, C3-34iF, C3-34iI, C3-220A, C3-34iO, C3-220I.

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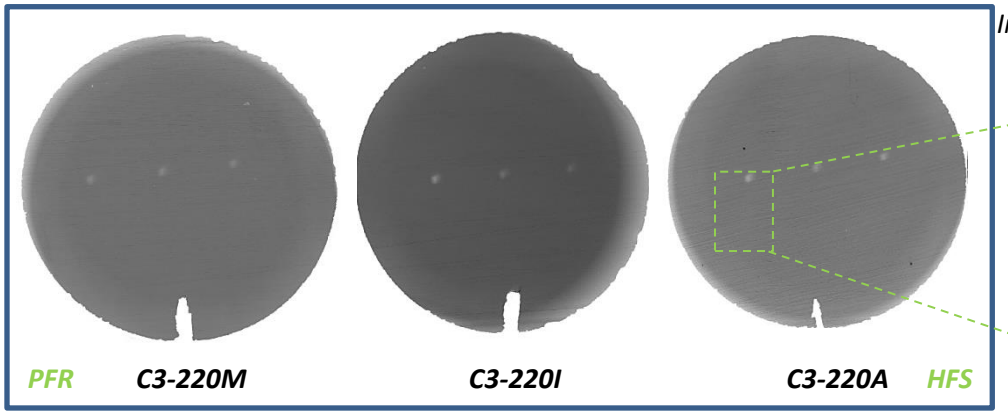
Digital microradiograph (expressed S-coordinate scheme)

*High resolution X-ray microradiographies (*13.3 µm/pixel*) of samples retrieved from WEST Surface contaminant on C3-220A; delaminations on C3-34iI & C3-34iF; SIMS marks visible.*

Inner marker tile



Impurity detected

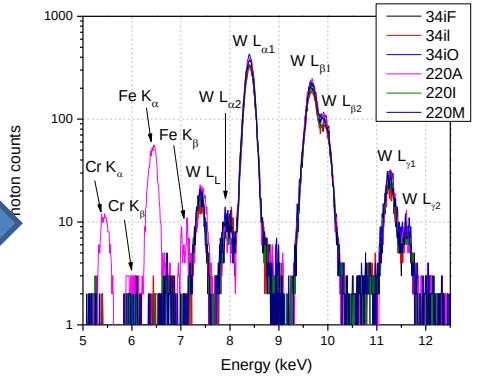
SIMS measurement marks

Some erosion

Some deposition

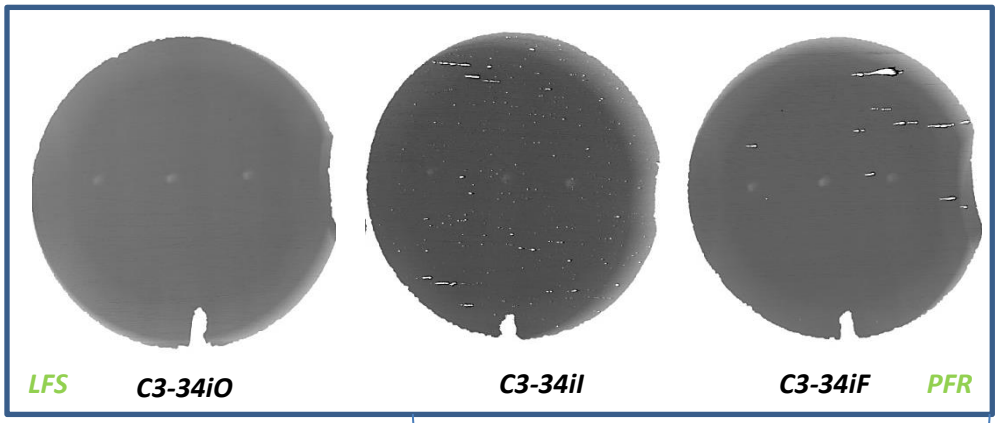
X-ray attenuating particles

- **Surface contimination overview via microbeam X-ray fluorescence (microXRF)**

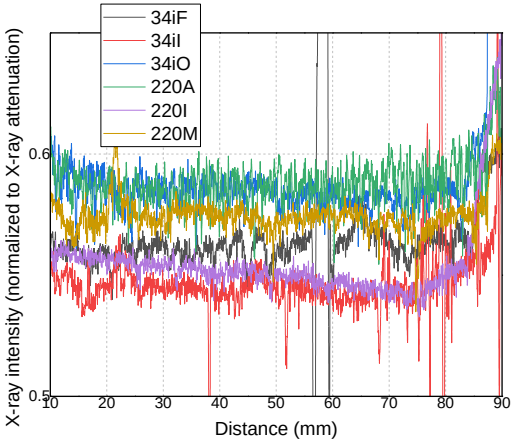


C3-220A: Cr 0.88 ± 0.1 and Fe 2.54 ± 0.1 (wt.%).

Outer marker tile

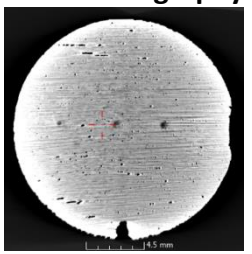


Surface artefacts



X-ray intensity correlated with X-ray beam attenuation (high values spikes = erosion Low values = deposition)

Microtomography

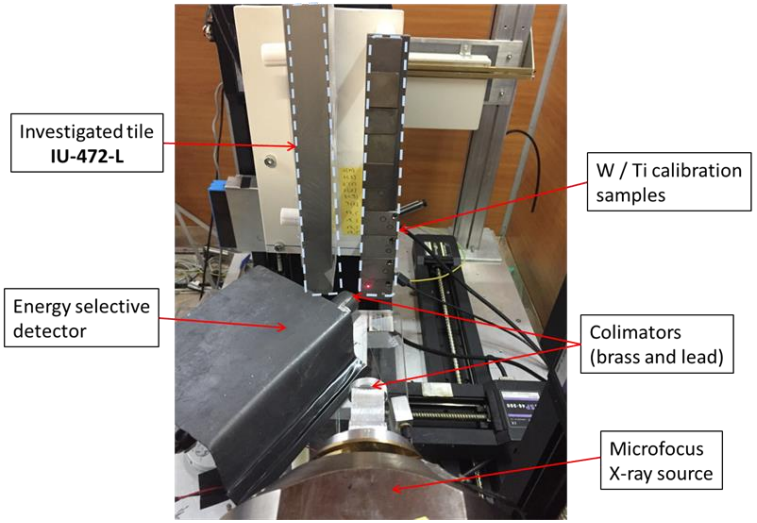


C3-34iI

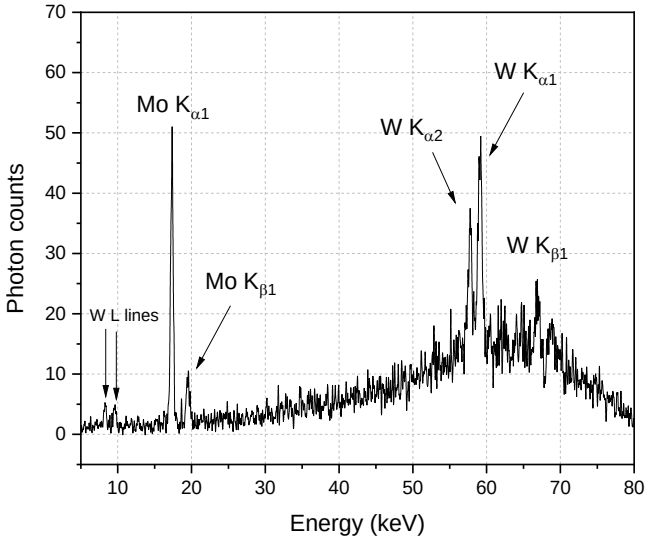
Tomography cross-sections (at 12.3 µm/voxel) Overviewing pores down to 50 µm.

X-ray imaging methods as microradiography and microtomography can perform an overview analysis of the microstructural integrity

Ad-hoc W K-line X-ray fluorescence (HEXRF) setup

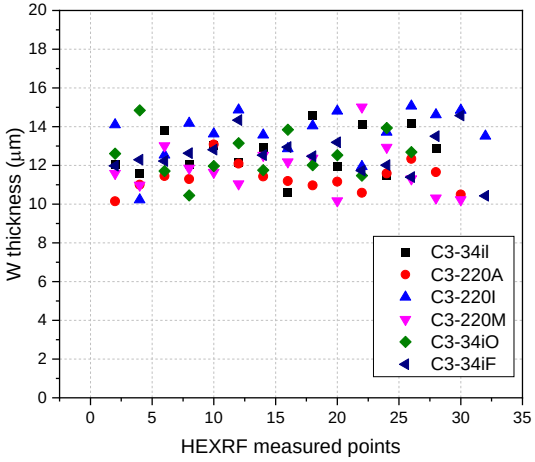


X-ray fluorescence spectra of W and Mo K-lines;

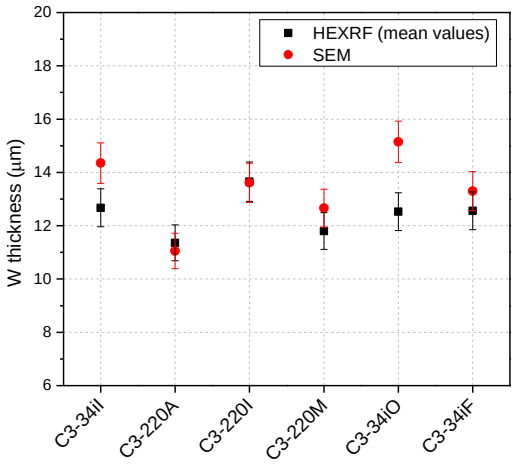


W K-line XRF, not available on the commercial XRF instruments, can be used to determine thicknesses of W layers up to 100 µm without sample preparation

W thickness measurement by W K-line XRF



Comparison to SEM measurements (cross-section on mark)



Conclusions

- X-ray radiography, XCT and XRF-based methods were applied as non-destructive techniques on samples exposed to tokamak plasma
- Relatively simple alternatives to other well-known inspection methods;
- Ability to cope with samples containing impurities in the form of alloys as minor components and/or contaminants, or dust microparticles on the surface of the samples;
- Advantage: **Rapid, versatile** and **adaptability** to sample's roughness, geometry excluding the need for special sample preparation;