Plasma surface interaction issues for steel as plasma-facing material – FZJ perspective: What experimental capabilities are available?

B. Unterberg
Institut für Energie- und Klimaforschung – Plasmaphysik
Forschungszentrum Jülich, Ass. EURATOM- Forschungszentrum Jülich, Trilateral Eurorad Cluster, D-52425 Jülich, Germany

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Important aspects to be discussed for steel as plasma facing materials (con’t)

Fuel retention in steel with possibly modified surface composition
- Quantification of fuel retention in steel: impact of temperature, plasma impurities and surface morphology
- Characterization of trap sites (energy)
- Isope exchange in steel
- T permeation – development of permeation barriers
- Impact of irradiation defects on fuel retention in steel – compare damage by high energy ions and neutrons
- Comparison to diffusion trapping codes – coupling to codes which describe (preferential) sputtering?

Estimation of diffusion length of W in EUROFER

Diffusion length comparable to depth of enrichment zone
-W enrichment by preferential sputtering should be assessed experimentally!

Facilities at FZJ to investigate synergistic effects from heat and plasma load

Linear plasma device PSI-2 and laser irradiation facility
Further capabilities for post-mortem analysis:
- TDS / LID-QMA
- GDOES
- ion beam analysis (NRA, RBS, ERD) with tandem accelerators
- NRA, RBS, ERD, XPS and TDS on poly- and single-crystal samples (ARTOSS facility)
- FIB/SEM
- XPS, XRD
- Mirror lab

Analysis of virgin EUROFER sample by GDOES (no surface preparation)

<table>
<thead>
<tr>
<th>Element</th>
<th>Mass%</th>
<th>Limit of det. %</th>
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<tbody>
<tr>
<td>Fe</td>
<td>95.0%</td>
<td>0.48%</td>
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<tr>
<td>W</td>
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<td>C</td>
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<tr>
<td>O</td>
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<td>0.22%</td>
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<tr>
<td>N</td>
<td>0.1%</td>
<td>0.12%</td>
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Linear plasma device PSI-2

Coils
Side-fed manipulator
Target station
TeAC
Plasma source
Laser techniques for surface characterization

- LIDS
  - In vacuum: LID
- LIAS
  - In vacuum: LIA
- LIBS

Laser break-down spectroscopy – example of a LIBS plasma in front of a aC:H on W layer

High resolution spectra from cross-dispersion echelle spectrometer

- Laser energy density 18 Jcm\(^{-2}\)

Laser induced desorption of hydrogen

- Qualified in the lab and extensively used at TEXTOR
- Currently being set-up at PSI-2

Graphite EK98 target exposed to TEXTOR plasma, LID measurement: 2.2\(\times\)10\(^{17}\) H/cm\(^2\) (±30%)

JULE-PSI – a new plasma device inside a Hot Cell to investigate PMI with n- irradiated materials

- PISCES-type plasma source
- Major components ordered (exposition chamber, magnets, pumps)
- Assembly outside controlled area I/2015