

Erosion/deposition measurements using marker techniques

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Motivation

Understanding of material transport in fusion devices

- Light versus heavy elements
 - ⇒ Investigation of divertor erosion/deposition in AUG during transition from C-dominated to full-W machine
 - ⇒ Transport of light and heavy elements in the same device
- ITER will start with a full-W divertor into the DT-phase
- A full-W device is the most promising option for DEMO
 - ⇒ AUG already allows to study W transport in a full W machine





Experimental methods

Methods:

- Analysis of marker layers before and after exposure for one campaign
- Analysis of regular tiles (D inventory)





Experimental methods (2)

Marker stripes in full-W machine

- W marker stripe for net erosion/deposition
- Uncoated C area for net deposition
- Layer thicknesses by RBS

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Net erosion<sub>PostMortem</sub> = N_{Before} - N_{After}
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 $N_{\text{Before}},\,N_{\text{After}}$: Amounts of W before and after exposure







W erosion/deposition in the AUG divertor

Morphology of W erosion: Outer divertor







Initial: 1.5 μm W Mean erosion: 0.28 μm Max erosion: > 1.5 μm

Very inhomogeneous erosion of marker

- \Rightarrow 5 to 10 times larger local erosion on plasma-exposed surfaces than mean
- \Rightarrow Some W deposition in shadowed areas

Erosion of W on rough surfaces



- Inhomogeneous erosion due to combined effect of magnetic field + electrical sheath K. Schmid et al., NF 50 (2010) 105004
- Erosion by D, B, C, O-ions predominantly on leading faces
- Small (or no) erosion in shadowed areas and pores



Deposition of eroded W on rough surfaces



 Almost homogeneous re-deposition of eroded W on rough surfaces
K. Schmid et al., NF 50 (2010) 105004



Surface modifications after 2009 campaign



After exposure



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PP

- ~10 μ m thick CMSII layers (C. Ruset) at outer strike point
- 5275 plasma seconds

MF Ringberg November 2010 © Matej Mayer

Surface modifications



Before exposure

After exposure



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Properties of re-deposited layers

M. Rasinski et al. SOFT 2010

Marker samples for JET ITER-like wall

- Main chamber: Be on Inconel
- Divertor: W (bulk + 20 µm on CFC)
- PWI questions:
 - Mixed material formation?
 - D inventory?
 - Erosion, re-deposition, transport?
 - Transport of Be, D to remote areas?
 - Comparison to C?

Marker coatings: Divertor

IPP

- 4 6 µm W marker coatings for erosion/deposition studies
- on 30 divertor tiles
- on 12 lamellas for tile 5

• Marker stripes: Mo, W on W \Rightarrow demanding data analysis: roughness + plural scattering

 \Rightarrow Simulation improved for complex samples

Conclusions

Marker measurements provide important information on

- Net erosion and deposition areas
- Global material transport
- Properties of redeposited layers
- Deuterium inventory

ASDEX Upgrade

- Net W erosion in outer divertor, W redeposition in inner divertor
- Very inhomogeneous W erosion on rough surfaces

JET

 Marker samples for W erosion/deposition measurements on bulk W and thick W coatings