P05B

Modelling of Deposition at the Bottom of Gaps in TEXTOR Experiments

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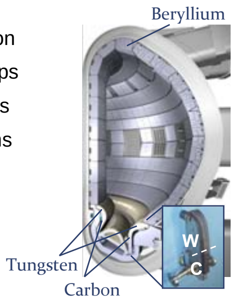
Motivation

ITER issues : Material lifetime and long-term T retention
Castellation : T co-deposition with C and Be inside gaps
PFC gaps : Not accessible by most cleaning techniques
Essential task : Understanding deposition mechanisms

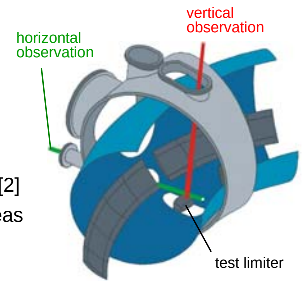
Tools : Dedicated experiments and modelling
Ultimate goal :
Predictive modelling of long-term tritium retention



Introduction

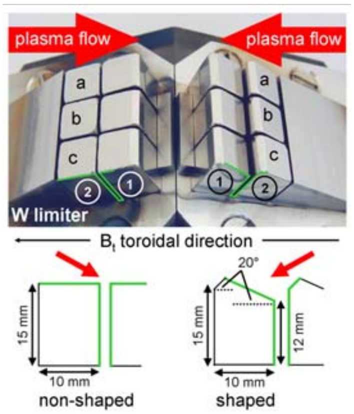
Experiments at TEXTOR
→ Experiment with castellated test limiter [1]
→ Experiment with Quartz Micro Balance (QMB) measurements of deposition in a gap

Modelling with the 3D-GAPS code
→ Monte-Carlo neutral / impurity transport code [2]
→ 3D geometry - Gaps & Plasma-Shadowed areas
→ Coupling with ERO simulations [3]
→ Plasma background from PIC simulations [4]



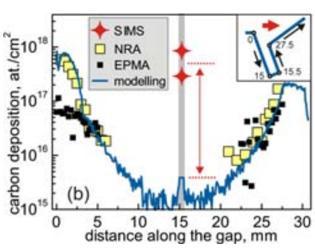
Castellated limiter

Experiment
- W limiter, two shapes of castellation
- 16 reproducible NBI discharges (110 s)
- Loss of plasma position in 3 shots
- Deposition of C layers (up to 500 nm)
- Up to 14% of C deposited at the bottom!



3D-GAPS modelling
- D^+ ion flux distribution over the surfaces inside gaps from PIC simulations
- Particle reflection (best fit): $R(C) = 0.6$; $R(D) = 0.7$; $R(C_xD_y) = 0.9$
- Sputtering at plasma-wetted areas
- Chemical erosion by D atoms and ions
- $Y_{chem} = 0.5\%$ (poloidal non-shaped gaps); $Y_{chem} = 2.0\%$ (poloidal shaped gaps)
- No neutral collisions (low D_2 neutral pressure), no CX effect (low flux ~1%)

Carbon deposition in poloidal gaps (modelling vs. experiment)

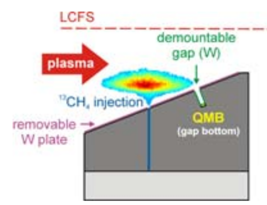


	Sides	Bottom
Experiment	1.4×10^{17} C	6-14%
Simulation	1.8×10^{17} C	~0.1%
EXP/SIM	**0.8**	**600-1400**

Rather good agreement for side surfaces

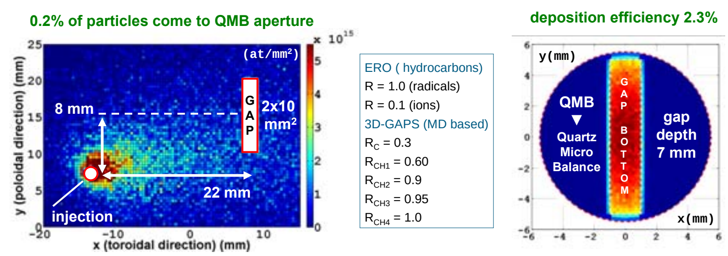
Deposition at the bottom cannot be reproduced by the modelling

Gap with QMB

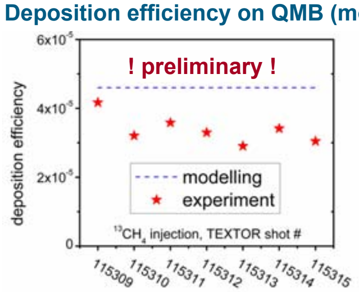


- addressing deposition at the bottom in gaps
- QMB – shot resolved in-situ measurements
- demountable gap for post mortem analysis
- $^{13}CH_4$ injection – source quantification and better sensitivity
- coupled ERO and 3D-GAPS simulations

Modelled deposition patterns on the limiter surface and on QMB



Deposition efficiency on QMB (modelling vs. experiment)



- 7 injections with rate ~ 4×10^{19} $^{13}CH_4$/s
- Results of preliminary data analysis and modelling agree well
- Injection #5 – disruption, no visible effect on deposition efficiency!
- Re-erosion not taken into account in the modelling for the moment

see also:
ERO simulations for QMB – A. Kirschner (**P05A**)
H tracing in ERO – O. Van Hoey (**P33A**)

Discussion & Outlook

Large deposition at the bottom in gaps of castellated test limiter
→ Is not reproduced by 3D-GAPS modelling
→ Are the models used in 3D-GAPS appropriate (e.g. angular distribution of reflected particles)?
→ Can the deposition be attributed to off-normal events or be design specific (e.g. open gap sides)?
→ Can this happen in ITER?

QMB diagnostics for in-situ shot-resolved measurements of bottom deposition
→ Possibility of post-mortem analysis
→ Ideal tool for code benchmarking
→ In good agreement with modelling predictions (although some processes that may play a role, e.g. re-erosion are not yet taken into account)
→ First results show no effect of disruptions

What would be the next steps?
→ Re-erosion by H^0 and H^+ from plasma and puff
→ MD reflection data for low particle energies
→ Comparison of modelled deposition profiles with post-mortem analysis (gap side and QMB)
→ New experiment (QMB, only background C)
→ Application of 3D-GAPS to remote areas (JET)
→ Predictive modelling for ITER…

[1] A. Litnovsky et al, JNM 390–391 (2009) 556
[2] D. Matveev et al, accepted for publication in PPCF (2010)
[3] A. Kirschner et al, Nucl. Fus. 40 (5) (2000) 989
[4] R. Dejarnac, J. P. Gunn, JNM 363–365 (2007) 560