Modelling of carbon deposition from CD_4 injection in the far Scrape-Off Layer of TEXTOR

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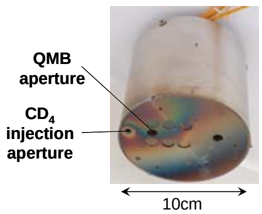
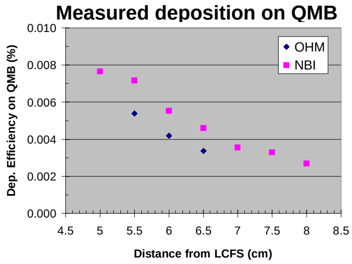
Motivation:

Layer deposition at remote areas is suspect of resulting in long-term tritium retention in ITER. Transport to and deposition at remote areas is an important issue. Approach: experiment in combination with modelling.

Experiment: CD_4 injection in TEXTOR

Cylinder mounted with QMB exposed to far Scrape-Off Layer (SOL) in TEXTOR, cylinder top surface parallel to B-field: negligible ion flux to surface. Shot-resolved C deposition on QMB from CD_4 injection.

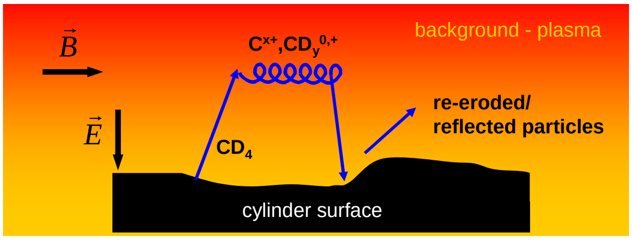




- Deposition on QMB increases if cylinder is deeper in plasma.
- Slightly larger deposition for NBI than for ohmic discharges.

For details: H.G. Esser et al., PSI 2010

Modelling: The 3D MC code ERO

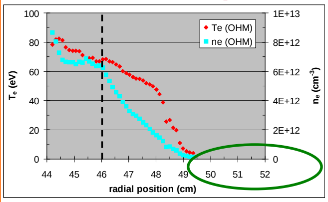


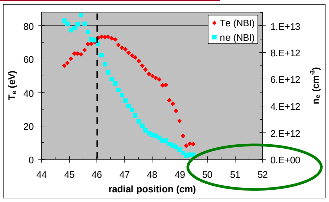
plasma-wall-interaction:
- physical sputtering/ reflection
- chemical erosion (CD_4)
- deposition from background
- redeposition of eroded species

impurity transport:
- ionisation, dissociation
- friction, thermal force
- Lorentz-force
- cross field diffusion

For details: A. Kirschner et al., NF 2000

Plasma parameter for modelling:





Assumptions for far SOL (r>~49cm):

Ohmic: T_e=4.3eV, n_e=1e11cm^{-3} **NBI: T_e=9eV, n_e=1e11cm^{-3}**

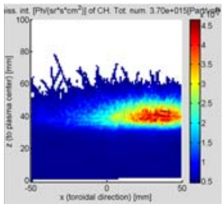
Conclusions:

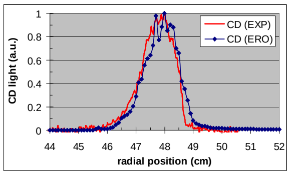
In contrast to plasma-wetted areas: modelling does not need enhanced re-erosion of deposited layers at remote areas. To reproduce measured deposition MD reflection coefficients for low energetic species are necessary. Erosion due to D^0 erosion improves agreement.

Modelling results:

I) Ohmic plasma, $d_{cylinder}$= 6cm

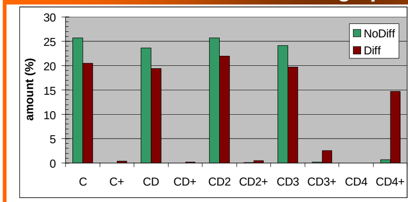
- CD light emission -





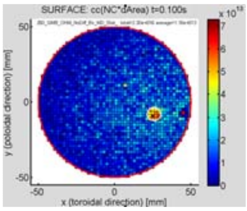
Modelled penetration as in experiment

- Returning species -



Impact energy < ~3 eV => MD reflection

- Deposition on cylinder surface -



On QMB: R = 0 (to get flux)

On disk (from MD, Ohya):

$R_{CH4} = R_{CH3} = 1$, $R_{CH2} = 0.9$, $R_{CH} = 0.6$, $R_C = 0.3$

Deposition efficiency on disk: ~2.2%
(experiment: from all shots ~1%)

II) Parameter variations: diffusion, T_e, n_e

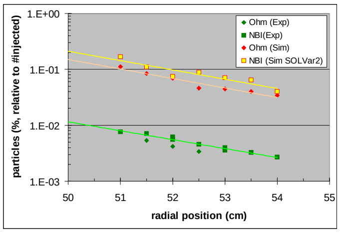
	OHM standard	OHM diffusion	OHM plasma variation	NBI standard	NBI plasma variation
Flux to QMB	$6.9\cdot10^{-2}$%	$9.6\cdot10^{-2}$%	$8.7\cdot10^{-2}$%	$7.5e\cdot10^{-2}$%	$14.7\cdot10^{-2}$%
Deposition on cylinder	2.1%	2.1%	2.2%	2.5%	2.9%

OHM diffusion: $D_\perp$=0.2m²/s

OHM variation: increased T_e in far SOL (4.3→9eV)

NBI variation: increased n_e in far SOL (1e11→2.8e11cm^{-3})

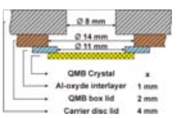
III) Parameter variations: radial scan

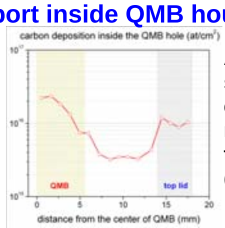


ERO modelled flux about 15 times larger than deposition observed on QMB

IV) Transport inside QMB housing: 3D-GAPS

Geometry of housing





About 20% of entering species (from ERO) are deposited on QMB: modelled deposition ~3 times larger than observed (D atom erosion)

3D-GAPS: D. Matveev, P05B