

DITS project: mapping of the topology of the erosion and deposition zones at the surface of the toroidal pump limiter

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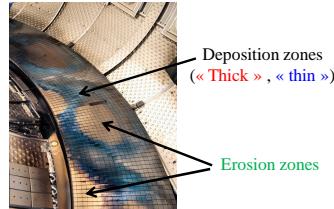
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The Deuterium Inventory in Tore Supra campaign

The DITS campaign [1] → Aim: Load the PFCs in D

- Boronisation marks the beginning of the DITS campaign
- *in situ* particle balance: 10 g of D retained
- 30° Toroidal Pumped Limiter (TPL) dismantled
- Do *ex situ post mortem* analyses on C/C tiles [2]

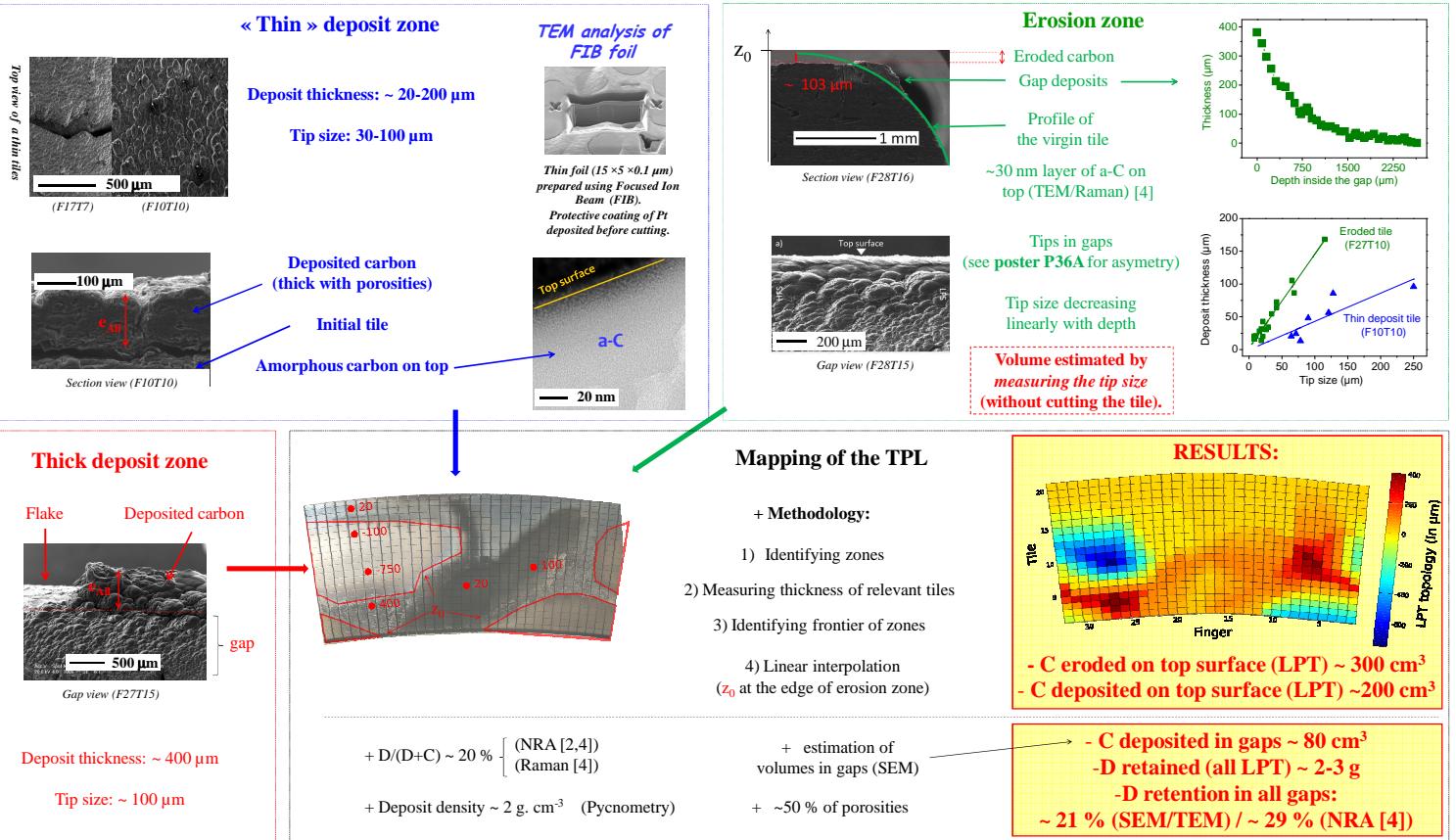
Fuelling:
DITS : $1.8 \cdot 10^4$ s Injected energy:
DITS : $2.14 \cdot 10^4$ MJ
All: $1.4 \cdot 10^5$ s RATIO: 0.13 All: 2.06 $\cdot 10^5$ MJ RATIO: 0.10



Aim of this work

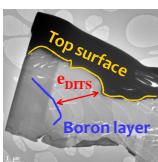
- 1) Topology of the TPL:
→ Estimation of eroded and deposited carbons (on tops surfaces and in gaps)
- 2) D retention on the TPL:
→ Estimation of D (on tops and in gaps)
→ History of deposits
- 3) History of growth/erosion (DITS+before DITS)

Mapping of the LPT



Deposit history

TEM/FIB + EDX



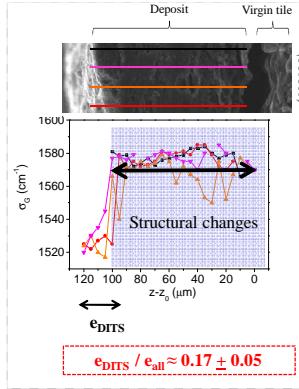
Boron layer detection in the thin deposition zone

- Boron layer at 2.6 µm depth
- Thickness of the deposit = 20-30 µm [4]

$$e_{DITS} / e_{all} \approx 0.09-0.13$$

Raman spectroscopy

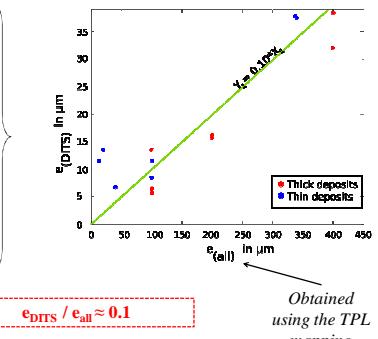
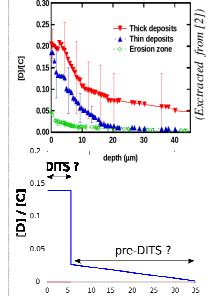
- Local probe of atomic structure (vibration)
Lateral ≈ 1 µm², depth ≈ 70-300 nm
D-band (C=C)
G-band (C=C)
Photoluminescence → Give access to D/C
Blue-shift of the G band → local organization of the material [4,5]



- Agreement between the three techniques: $e_{DITS} / e_{all} \approx 0.1$, roughly independent of the zone
- Structural changes in depth correlated to the D loss before DITS → Role of the cycling ?

Nuclear reaction analysis

Collaboration with M.Mayer (IPP Garching), in progress



Conclusion / Perspectives

- C eroded ~ C deposited in gaps + C deposited on TPL
- Raman and NRA measurements agree on D/D+C ~ 20 %
- 20-30 % of retained D is found on the TPL
- In depth structural changes of deposits before DITS correlated to D-loss
- Erosion and deposition rates during DITS roughly similar to before DITS

References

- [1] B. Pegourie, et al., J. Nucl. Mat. 390-91, 550 (2009)
- [2] T. Dittmar, et al., Phys. Scr. T138, 014027 (2009).
- [3] M. Richou et al., Carbon 45, 2723 (2007)
- [4] C. Martin, et al., T. Dittmar et al., C. Pardanaud, et al., Journ. of Nuc. Mat. (2010)
- [5] A. C. Ferrari and J. Robertson, Phys. Rev. B 61, 14095 (2000)