Be-induced Control of Carbon Sputtering

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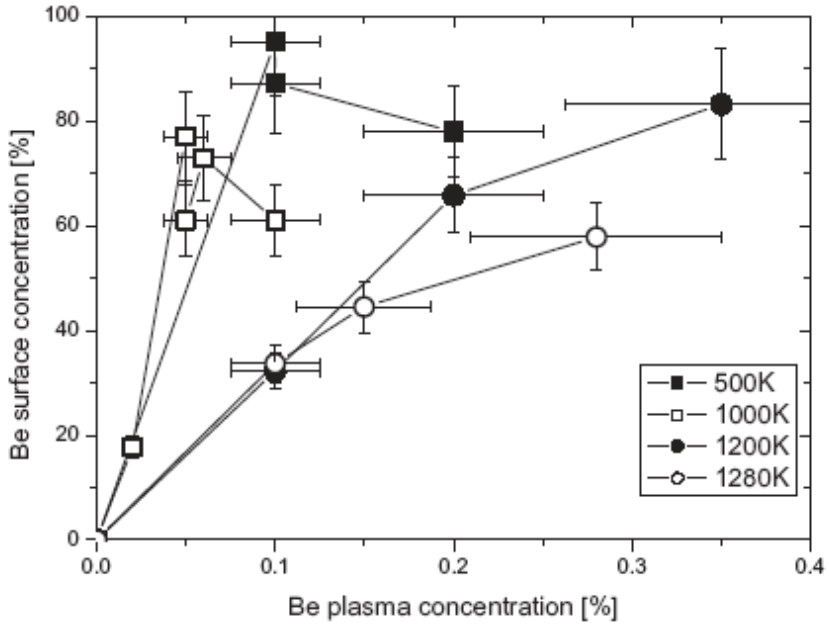
- Tritium retention and erosion are the main issues for the usage of carbon in burning plasma experiments
- However, expectations of tritium retention and erosion, which are made for ITER are based on a single material approximation even though the ITER first wall materials are chemically active C, Be, and W
- But recent experiments on PISCES (see for example Schmid et al., NF 2004) show that even small ($\sim 0.1\%$) fraction of Be, ξ_{Be}, added to hydrogen plasma decreases spattering of carbon sample by order of magnitude

- It seems that reduction of sputtering yield is due to almost complete coverage of the graphite substrate with Be layer preventing further erosion of carbon
- Such layer is formed at a small Be fraction in plasma!



(Schmid et al., NF 2004)

- It is plausible that the formation of Be layer if induced by the formation of strong Be-C bonds

- As a result it:
  a) causes reduced re-erosion of Be from graphite substrate and
  b) seeds the Be layer over the substrate

- For small substrate coverage with Be, the evolution of the Be surface concentration [Be] can be described with

$$\frac{d[Be]}{dt} = S_{Be}\Gamma\xi_{Be} - Y_{Be}^{eff}\Gamma[Be] \quad \Rightarrow \quad [Be] = S_{Be}\xi_{Be} \big/ Y_{Be}^{eff},$$

where Γ is the plasma flux, S_{Be} is the "sticking probability" and Y_{Be}^{eff} is the effective sputtering yield

- Large values of [Be] observed for a small Be fraction ξ_{Be} can be explained by a small sputtering yield Y_{Be}^{eff}

- However, Y_{Be}^{eff} can depend on the morphology of the surface, magnitude of Γ, surface diffusion D_{Be} of Be atoms, etc.

- Moreover, recent experimental data from T-10 (Khimchenko, EPS-2004) suggest that strongly intermittent edge plasma transport results in a highly fractal structure of the first wall surface

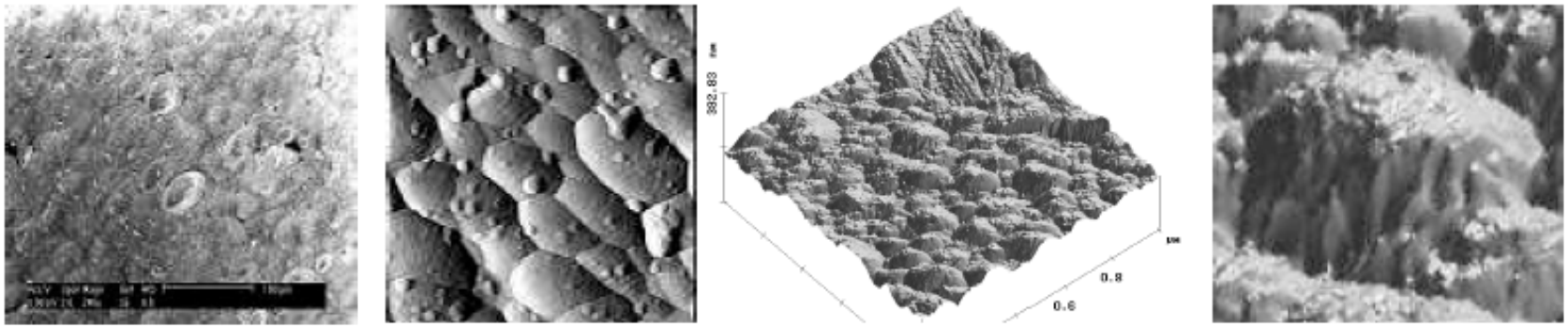


Fig.1. Films images with full size: a-300µm, b-5µm, c-1µm, d-50nm,

Khimchenko et al., P-4.146, EPS-2004

- The morphology of the surface strongly related to dust formation, which is an important (but yet poorly understood!) issue for burning plasma experiment
- At this moment the is no model/code addressing this important area of Plasma Facing Component research
- We suggest to develop physical model and build up the code (-s) focused on description the property of first wall surface in the presence of chemically active mixed materials
- We envision that this work will be in a close collaboration with experiment studies which are going on PISCES and on tokamaks

- A one-day meeting "**Dust in Fusion Plasmas**" will be held on April 5, 2005 in the Chardonnay "C" room of The Embassy Suites Napa Valley, Napa, California, USA
- The format: short (~ 20 min) oral talks and a lot of discussions
- The "DFP" meeting is organized as a satellite of the US TTF Meeting, which will be held at the same hotel on April 6-9, 2005
- To attend the DFP Meeting (attendance is free of charge) send e-mail by February 1st with your name, affiliation, and e-mail address to Claudia Hennessy <chennessy@vlt.ucsd.edu> referring to "DFP-2005