Overview of the Recent DiMES and MiMES Experiments

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This talk
- Studies of the main chamber erosion with MiMES
- Hydrogenic retention in gaps between PFCs
- Mirror studies

Next talk – D. Buchenauer for W. Wampler
- Tungsten, D trapping at damage and erosion
- Carbon erosion by neon detached plasma

Later this session – dust talk
- Injections of pre-characterized dust
MiMES shows net deposition in high-density H-mode, tendency to net erosion in lower-density H-mode

- Two depth-marked graphite buttons were exposed for total of ~30 plasma-seconds in high-density \((n_e/n_{GW} \sim 1)\) H-mode with small ELMs \((\Delta E_{ELM} = 6-10 \text{ kJ})\)

- After exposure, visible deposits appeared on the sample holder

- IBA showed net deposition of 24 (±10) nm of C on button A and 40 (±10) nm on button B

- Exposure was repeated in a lower density H-mode \((n_e/n_{GW} \sim 0.45)\) with larger ELMs \((\Delta E_{ELM} = 30-45 \text{ kJ})\)

- IBA showed net erosion of 13 nm on button A and 10 nm on button B (barely out of the measurements error bars)

- With larger ELMs main wall erosion is more likely
In previous experiments at DIII-D, a reduction of carbon deposition rate by a factor of 3-4 and an order of magnitude reduction of deuterium co-deposition inside the gap were achieved when the sample temperature was increased from ambient conditions ~30 C to 200 C [1].

There was a suspicion that some of the carbon may have reacted with silicon catcher plate at high temperature.

Experiment was recently repeated with copper catcher plates at temperatures between 200-300 C.

Further reduction of deuterium co-deposition was observed compared to the previous heated exposure. D areal density was below NRA resolution of $10^{13}$ C atoms/cm$^2$.

Experiments in TEXTOR showed a significant reduction of fuel inventory in shaped cells compared to rectangular ones, though amount of deposited carbon was similar [2].

Aims of the experiment in DIII-D:

- study the major process leading to the deposition in gaps in the private flux region
- further clarification of the impact of shaping on carbon deposition and fuel accumulation in the gaps

Rectangular and shaped blocks exposed together on a specially designed DiMES holder.

Castellation exposures in DIII-D

- **Dedicated short-term experiment (2009):**
  - Exposure in the private flux region of high-density LSN H-mode discharges
  - 10 highly reproducible discharges, total exposure time ~40 seconds
  - Analysis shows difference in C deposition patterns on the plasma shadowed sides of cells: e-folding length ~2.4 mm in strongly shaped cells and ~1 mm in moderately shaped cells
  - similar amount of accumulated C in strongly and moderately shaped cells

- **Piggyback longer-term exposure (2009)**
  - Sample exposed to a variety of plasmas over 3 days of plasma operations
  - Visible deposits on the top and side surfaces
  - Substantial deposition inside gaps
Two mirrors installed in MiMES have been exposed in outboard main chamber to 20 high density L-mode discharges for a total of about 60 s.

Upon extraction, no visible deposition were observed on the mirror viewing the divertor, while the toroidally viewing mirror exhibited visible deposits, though it was further away from the plasma.
Exposed mirrors were analyzed at the University of Basel.

Ellipsometry measurements revealed a carbon layer on toroidally-looking (Rh-coated) mirror with thickness of 5-10 nm.

The total reflectivity of Rh-coated mirror decreased by 10-15% in the wavelength range between 200-400 nm, while the reflectivity of the mirror viewing the divertor decreased by less than 5%.

Orientation matters!
Mitigation of carbon deposition on mirrors by a local gas injection

- Aim of the experiment: protect mirrors installed below the floor in PF zone by mitigating C deposition.

D feed in the vicinity of the mirrors may mitigate the deposition by the following essential processes:

1. Lowering the C/D ratio in the plasma in the vicinity of mirrors
2. Increased probability of elastic and inelastic collisions of C ions/atoms with D thus lowering the chance for C to reach the mirrors (collisional damping).
3. Dissociation of D₂ molecules may provide a source for chemically reactive D atoms to effectively bind C before reaching the mirrors (chemical damping).
4. Increased chemical re-erosion rate

"Gas blow" technique successfully tested in TEXTOR [A. Litnovsky et all, Nucl. Fusion, 49 (2009) 075014]
Gas injection mitigated deposition

- Two mirrors exposed for total of \( \sim 30 \) plasma-seconds in high-density \( (n_e/n_{GW} \sim 1) \) ELMing H-mode

- Observed deposition was lower by a factor of more than 10 compared to non-mitigated case
Summary

- Net deposition of carbon was measured near the outboard chamber wall in high density H-mode with small ELMs while in lower density H-mode with larger ELMs tendency towards net erosion was observed.

- Preliminary analysis of castellated sample exposed in private flux zone shows difference in carbon deposition patterns, but similar amount of accumulated carbon in strongly versus moderately shaped cells.

- Carbon deposition rate on diagnostic mirrors located near the outboard wall has a strong dependence on the mirror orientation.

- Local gas puff was effective in mitigating carbon deposition on mirrors in a detached divertor.