Surface Science Station (S3): a real-time diagnostic of boronization in Alcator C-Mod

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Introduction and motivation:
High-Z plasma facing components (PFCs) are favored for application in fusion reactors:

- Low tritium retention
- Low loss emission
- High resistance to thermal fluxes

Disadvantages:
Low plasma volume to high-temperature limit in de-tritiated plasma performance [1]

Solution for Alcator C-Mod, armed with only high-Z and medium-Z tiles:
- Application of low-Z coating (boron) on PFCs via boronization

Previous boronization studies on Alcator C-Mod show:
- Electron Cyclotron Resonance (ECR) heating is used to apply boron films to PFCs [2-4]
- Effect of boron coating is limited to ~ 20 high power discharges [2]
- Previous boronization studies on Alcator C-Mod show:
  - High resistance to thermal fluxes
  - High-Z plasma facing components (PFCs) are favored for application in fusion reactors:

Introduction and motivation:
- Capable of linear translation along major radius for R > 0.58 m
- Inability of the ECR antenna to resonate through application of a vertical field component.
- Demonstrates that background He species play little role in boron removal and deposition during boronization
- Deposition is independent of surface orientation to magnetic field shows wide scatter
- Deposition rate appears to saturate at highest throughput
- As particle throughput ~ 0.2 Pa*m^3/s, deposition rate increases with particle throughput
- Deposition rates with no correlation to particle throughput
- He-only ECD plasmas show minimal boron film erosion
- Collisional effects of higher neutral pressure?
- Finite larmor radius allows non-zero deposition on QMB1 surfaces to simulate deposition from the radial distance to the B field resonance location assuming n_e ~ 10^16/cm^3

Conclusion and key results:
- Boron deposition rate increases with particle throughput
- Boron deposition is dominantly ionic
- There is a broad effect of the vertical B field on deposition
- Boron deposition rate increases with particle throughput
- Important at n_e > 1x10^15/cm^3
- Development of Monte Carlo model to predict deposition patterns for complex in-vessel 3-D structures like RF launchers, antennae, etc.
- Critical locations for RF-induced Mo source further outboard in R than previously thought
- B deposition limits and plasma density u < 5 below RF cutoff, therefore even RF power should lead to higher deposition rates by increasing plasma density
- 2nd harmonic RF could better localize plasma by avoiding UH resonance

Surface Science Station (S3) - main components and principle of operation:
Contains quartz micro balance (QMBs), see Figure 1 - QMBs - sensitive to boron films on QMB surfaces
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Experimental procedure and results (continued):
- B + neutral collisions
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Effect of surface orientation:
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