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Investigations on Boronization at tungsten ASDEX Upgrade

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Conditioning of the plasma-facing surfaces (PFSs) in fusion devices is essential for reliable plasma operation. In ASDEX Upgrade (AUG), boronization by a glow discharge in He with 10% of deuterated diborane is used as standard wall conditioning technique. Recently the PFSs in ITER were changed to full tungsten, which triggered strong interest in wall conditioning techniques currently used at full metal fusion devices.
Analysis of the existing data from AUG were presented at the recent PSI conference [1]. To fill the knowledge gaps, new diagnostics such as witness samples, quartz microbalance monitors (QMB) and manipulator systems were installed or activated.
During the last vent a new upper divertor was installed at AUG. This opportunity was used to remove all deposited layers from the PFSs. AUG was restarted without boronization coating to document the role of boronization on plasma start up after a vent. It turned out that it was not possible to gather useful discharges in this configuration. After boronization, plasma restart was immediately achieved.
QMBs are used to measure the layer thickness during the coating process. This allows collecting data for different glow anode configurations without venting AUG. A code was developed to estimate the position and number of anodes required for boronization of ITER [2]. To benchmark this code a coating with only 2 active anodes was performed in AUG. From the QMB data, a reduction of a factor of two of the layer thickness at a position close to a non-active anode was found, in qualitative agreement with the simulations, although the layers are much thicker than predicted.
Samples made of different materials exposed during the boronization were used to confirm the deposition. As the layers react with air, they were dismounted under nitrogen atmosphere and measured by ion beam techniques with air exposure <5min. Up to 75% of the boron input was found, indicating almost homogeneous deposition. The samples were exposed 24h to air and analysed again. Typically, 10% less boron was found for one boronization, whereas a second sample set proved to be more stable.

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[1] V.Rohde et al., PSI 24, NME, submitted
[2] T.Wauters et al., PSI 24, NME, submitted