Research on Dynamic Retention Measurement Using Fast Ejecting System of Targeted Sample (FESTA) in QUEST

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During long-duration discharges, plasma maintenance was achieved more than 1 hour with an assist of the temperature well-controlled metallic plasma facing wall (PFW) which is atmospheric coated by tungsten (APS-W) in QUEST (Q-shu University Experiment with Steady-State Spherical Tokamak) \cite{1}. In the QUEST experiments, it has been found that a redeposited layer of several tens of nm thickness caused by plasma wall interaction (PWI), and wall-stored fuel particles in the redeposited layer give a greatly enhancement on dynamic retention and play a significant role in fuel particle balance \cite{2}.

In the fuel retention static retention measurement has been frequently investigated by taking out exposed sample, while dynamic retention which is the main factor of particle emission during plasma discharge was only measured by nuclear reaction analysis (NRA), and sufficient data has not been acquired. In addition, since dynamic retention significantly depends on PWI as described above, utilizing an actual fusion experimental device is essential to understand the real dynamic retention. We have developed the Fast Ejecting System of Targeted Sample called FESTA to resolve the problems.

A series of FESTA operation is programed to pick up a sample, to expose it to a targeted plasma, to rapidly extract the sample at any time. The plasma-exposed sample is left in a small chamber using a programmable arm and then the chamber is isolated by closing gate valves, and the outgas from the sample, that is caused by the dynamic retention, is measured with QMA (quadrupole mass analyzer).

In the FESTA experiment, some H\textsubscript{2} gas as background is admixed into the measured H\textsubscript{2} partial pressure, so the same operation w/o sample was conducted so as to assess the unexpected H\textsubscript{2} partial pressure. Consequently, it is known that the amount of the background greatly depends on plasma discharge duration, which indicates that H particles were also occluded by the chamber wall during the discharges. In order to obtain the dynamic retention from the sample, it is necessary to deduct the background amount. A model that evaluate the background was developed under several assumptions, and then the significant amount of H\textsubscript{2} desorption from the targeted sample could be obtained.

\cite{1} K.Hanada, et al. Investigation of hydrogen recycling in long-duration discharges and its modification with a hot wall in the spherical tokamak QUEST. Nuclear Fusion, 10, 2017