§41. Active Control Over Wall Recycling in a Spherical Tokamak: CPD by a Moving-Surface PFC

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Ever since the discovery of the "Supershot" confinement regime in TFTR experiments in late 1980's, it has widely been recognized in the magnetic fusion community that high performance core plasmas often favor reduced wall recycling. To reduce edge recycling, wall conditioning techniques such as boronization have been applied for many plasma confinement experiments. However, by nature, due to the surface saturation with trapped particles, the efficacy of wall conditioning has a finite lifetime, necessitating the shutdown of plasma operation for re-conditioning. Clearly, this is not acceptable from the point of view of operating steady state fusion power reactors. It is clear from these arguments that enabling wall concepts R&D is necessary for the successful operation of steady state fusion devices beyond ITER.

Over the past decade, therefore, a variety of innovative plasma-facing component concepts have been proposed to provide a resolution for this particle control issue. These concepts typically employ either a solid or liquid plasma-facing material, but both are continuously circulating for in-line regeneration of particle trapping capabilities. One such concept proposed by Hirooka et al. [1] employs a moving belt of SiC-SiC fiber fabrics with an in-line getter film deposition system.

In our previous work [2], proof-of-principle experiments on this concept with the moving belt, simplified by a belt of lithium deposited on a water-cooled rotating drum (see Fig. 1-(a)), were conducted at bombarding plasma densities of the order of $10^{10\text{-}11}$cm^{-3} and electron temperatures around 5eV. As shown in Fig. 1-(b) [2], spectroscopic data on H_α have indicated that steady state hydrogen recycling is reduced by 14% and 24%, respectively, at the lithium deposition rates of 9.5 Å/s and 7.3 Å/s due to the chemical codeposition effect, forming LiH.

In the present work, a compact spherical tokamak: CPD, located at the Kyushu Univ., will be installed with a similar rotating drum as the limiter head to investigate if the concept of MS-PFC can be used for active control over edge recycling in a confinement device, leading to an improvement of core plasma performance. A schematic diagram of the experimental setup is shown in Fig. 2-(a). For this purpose, a prototype rotating limiter made of tungsten-coated copper has been put together and is currently at the final stage before actual installation.

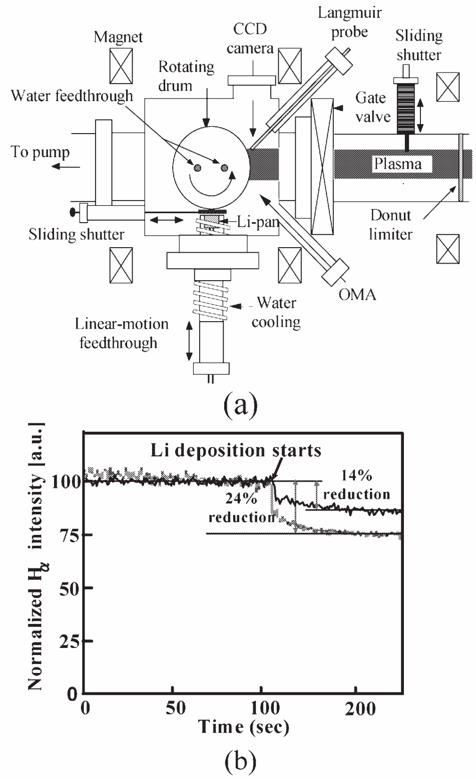

Fig. 1 A schematic diagram of the off-line rotating drum setup (a), and reduced steady-state hydrogen recycling from a lithium-gettered rotating drum [2].

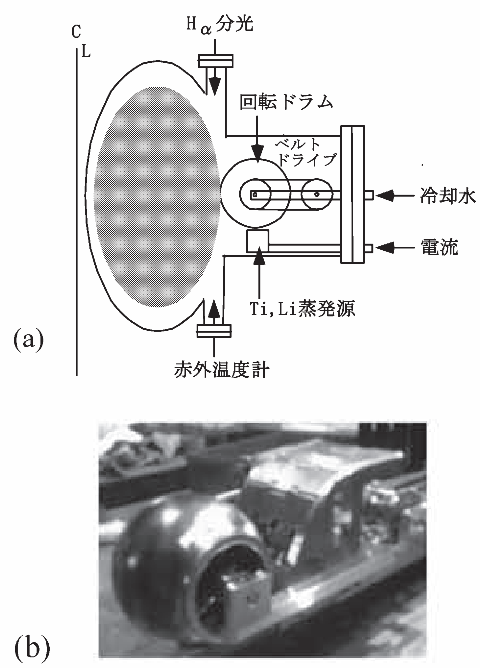

Fig. 2 A schematic diagram of the rotating drum limiter on the CPD spherical tokamak (a), and a close-up on the water-cooled rotating drum head made of copper.

References:

[1] Hirooka, Y. et al., Proc. 17th IEEE-SOFE, San Diego, Oct. 6th -10th , 1997, pp.906.

[2]Hirooka, Y. et al., Fusion Sci. & Technol. **47**(2005)703.