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TUNGSTEN TECHNOLOGY DEVELOPMENT IN KOREA AND ITS APPLICATION TO KSTAR EXPERIMENTS

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Main focus of fusion engineering has been moved towards development of metal wall plasma facing components (PFCs) and corresponding interaction between plasma and metal wall. National Fusion Research Institute (NFRI) has started metal wall related research activities since 2012, which are closely related to major upgrade of KSTAR and research on K-DEMO. As the first step, metal bonding technology has been developed and tungsten brazed block samples with good bonding quality have been obtained. Bonding technology for tungsten monoblocks using HIP is currently under development. Two major issues on tungsten divertors with castellated structure in ITER and beyond, are steady state and transient power handling capability and fuel retention inside the gap. Monoblocks aligned perfectly to their neighbors have leading edges directly exposed to plasmas. Leading edges under high power ELMy H-mode can be melted in several seconds of plasma exposure time. In order to solve this issue, radiated divertor and shaping of castellated monoblocks are proposed: Optimization of the shape and the angle of the castellation structure can reduce significant amount of heat load on the PFCs. Tore Supra has found that fuel retention was dominated by co-deposition, especially at the gaps of tile blocks. In order to study those two issues, special tungsten block tiles with various shapes of castellated structure with leading edges were fabricated and installed on the central divertor of KSTAR. It is found that the leading edge heat load can be described by using simple optical approach without Larmor orbit effect. Results also indicate clearly that the shape-optimized block has more heat load handling capability compared with conventional one, and the maximum temperature under heat load is much lower. The contributions of ions and charge-exchange neutrals on the deposition inside the gap of various shapes and heights of castellation structures have been measured and a complete set of deposition profiles inside the gaps was obtained. 0.3 mm misalignment allowed in ITER shows no meaningful difference on deposition profile. Since KSTAR has not enough heating power to sputter tungsten atoms from the blocks, transport of tungsten atoms in plasmas cannot be studied. We have developed a gun type powder injector to put tungsten powders into L- and H-mode plasmas, which provides evaporation of tungsten powders releasing a large amount of tungsten atoms. Vacuum Ultra Violet (VUV) spectroscopy, whose wavelength is around 6 or 12 nm, is used for the tungsten line measurement. Tungsten powder injection experiment has been successfully performed and the core accumulation of tungsten atoms is measured. Obtained tungsten emission spectra show very similar features measured at ASDEX Upgrade indicating tungsten atoms were evaporated from the powder and penetrated into the core. This has opened a new research area in KSTAR despite of low heating power.

Eligible for student paper award?

No

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