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Effects of ECH and RMP on Argon Impurity Transport in KSTAR Plasmas

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Experiments were conducted in KSTAR plasmas by injecting a trace amount of Ar gas as a test particle while applying two different actuators: electron cyclotron resonance heating (ECH) and resonant magnetic perturbation (RMP). Effects of ECH was investigated in KSTAR L- and H-mode discharges. For L-mode discharges (I_p = 400 kA, B_t = 2 T), 110 GHz ECH of 350 kW was applied to heating positions varied in the vertical direction. The Ar radiation, measured by soft X-ray (SXR) array diagnostics showed significant reduction in the core impurity emissivity with the ECH. The reduction was the largest by on-axis ECH heating and became smaller as the heating was delivered at outer locations. For H-mode plasmas (I_p = 600 kA, B_t = 2.8 T, P_NBI ˜ 4.0 MW), 170 GHz ECH of 800 and 600 kW was applied to the positions of Z = 0 at fixed R = 1.66 m. Emissivity measurements of 3.4 nm (Arˆ16+) by X-ray (XICS) and 35.4 nm (Arˆ15+) by VUV spectrometers indicate that the ECH reduced the peak emissivity of the Arˆ15+; however, the ECH increased the emissivity of the Arˆ16+. It was observed that the ECH effects for reducing (Arˆ15+) and increasing (Arˆ16+) emissivity were stronger with higher heating power. Ar impurity transport experiments using +90 phasing of n = 1 RMP was also studied in the H-mode plasma (I_p = 0.5 MA, B_t = 2.15 T, P_NBI ˜ 3.0 MW). The RMP coil current (I_RMP) was scanned from 0 to 2.5 kA and the trace Ar gas was puffed under the RMP. It was observed that the increase of I_RMP reduced line-averaged electron density by up to 15% and increased the ELM frequency from 52 Hz to 67 Hz. The peak divertor heat flux and stored energy loss during a single ELM burst were also decreased by the increase of I_RMP, along with mitigation of ELM by the RMP. The SXR radiation at the plasma core was decreased with the increase of I_RMP. These observations imply that the impurity accumulation can be controlled by the RMP application. A detailed discussion on the Ar transport coefficients, i.e. diffusion and convection coefficients, obtained by the ADAS-SANCO impurity transport code analysis will be presented. In addition, the analysis results from neoclassical and gyrokinetic simulation will also be discussed to provide theoretical understanding of the role of ECH and RMP on Ar transport in the KSTAR plasma.

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