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EX/P3-21: Enhancement of Edge Impurity Transport with ECRH in HL-2A Tokamak

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In next-generation fusion devices reduction of impurity concentration is of great importance for mitigating the radiation losses and the fusion fuel dilution to achieve a high confinement and high density plasma with a high radiation loss fraction at the edge for divertor compatibility. In HL-2A tokamak electron cyclotron resonance heating (ECRH) has been extensively carried out for the particle and impurity transport studies. The flattening of impurity density profile is frequently observed during the ECRH phase, while the interaction of plasma facing components with edge plasma and nonthermal electrons usually becomes stronger during ECRH phase. Radial profiles of impurity ions have been observed with a space-resolved vacuum ultraviolet (VUV) spectrometer recently developed in HL-2A, of which the intensity is absolutely calibrated using bremsstrahlung continuum. The impurity transport has been studied with this spectrometer in both edge and core plasmas for the ohmic discharges with ECRH using carbon emissions of CIII to CV.
A quick decrease against the electron density in the ratio of CV to CIV with ECRH is observed, but a gradual decrease of the ratio is obtained in Ohmic plasmas. The dependence of CV/CIV on ne in Ohmic plasmas can be explained by the change in the edge density where the CIV is located. However, the quick decrease of CV/CIV with ECRH is caused by a change of the transport of C4+ ions in the core plasma. The effect of electron temperature on CV emission is small. Based on the analysis of the radial profile of CV with a 1D impurity transport code an outward flux to carbon ions in the ECRH plasma and an inward flux in the Ohmic plasmas have been obtained in the core plasma. In the SOL region, the C2+ ions are moved upstream because the increased ion temperature gradient along magnetic field transfers impurity ions upstream, while the density gradient along the magnetic field transfers them downstream. The carbon transport in the SOL is enhanced for both the Ohmic and ECRH plasmas and radiation loss from carbon ions is increased in the SOL. The effect of impurity screening is reduced. The results indicate that ECRH puts out the impurity from the core plasma and enhances the radiation in the edge plasma, suggesting a favorable condition to next-generation fusion devices.

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