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Effect of resonant magnetic perturbations on metal impurity behavior in EAST tokamak

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In future tokamak devices, medium- and high-Z materials are used as plasma facing components. For example, from 2021, the first wall of the EAST tokamak is molybdenum tiles, the upper and lower divertor is tungsten-copper monoblocks, and the diagnostic protection shield and radio frequency wave antennas are iron and copper, respectively. However, impurities will inevitably be induced in plasma-material interaction in discharges, the presence of such impurities dilutes the fuel ion density and enhances the energy loss through radiation loss. These effects lead to a degradation of the confinement property. Therefore, according to the spatiotemporal evolution behavior of the line emissions and density distribution of medium- and high-Z impurity, passive spectroscopy can be used to study the transport process and mechanism of impurities, to explore the effective control means of impurities accumulation. At present, complete impurity diagnostic extreme ultraviolet (EUV) impurity spectrometer systems have been development on EAST.

In order to study the transport process and mechanism of impurity in EAST plasma, the metal spectral lines were systematically identified. It was found that when the electron temperature of the plasma core was 2.0-3.5 keV, Fe^{4+}-Fe^{15+}, Cu^{9+}-Cu^{18+}, Mo^{4+}-Mo^{21+} were mainly in the edge region of plasma, while Fe^{16+}-Fe^{23+}, Cu^{19+}-Cu^{26+}, Mo^{22+}-Mo^{31+} were located in the core region of plasma. In addition, 51 strong and isolated spectral lines were identified for the study of metal impurity transport. [1, 2]

The effect of resonance magnetic perturbations (RMP) application on impurity behavior in H-mode discharge with low q_{95} discharges dominantly heated by neutral beam injection was analyzed based on the temporal evolution and spatial distribution of impurity ions at the edge and core. Under the condition of applying RMP, the toroidal mode numbers, phase difference, and coil current of RMP, and q_{95} on impurity behavior were studied. The experimental results show that RMP with different static toroidal mode numbers can significantly suppress the intensities of medium- and high-Z impurity emissions in the core, while the radiation behavior of low-Z impurity emissions was related to the static toroidal mode numbers, i.e., the penetration depth of the penetration field. At the same time, it was also found that in static n=2 RMP, the odd parity coil configuration had a more significant suppression effect than even parity one [3]. In addition, it was found that in the q_{95} plasma with continuous scan in the range of 3.2-4.3, after the application of RMP, the radiation of medium- and high-Z impurities decreased rapidly and remained at a low radiation level, and the edge localized modes were fully suppressed. The suppression effect of RMP on impurities is dependent on both the RMP spectrum and plasma shielding effect on three-dimensional fields.

References
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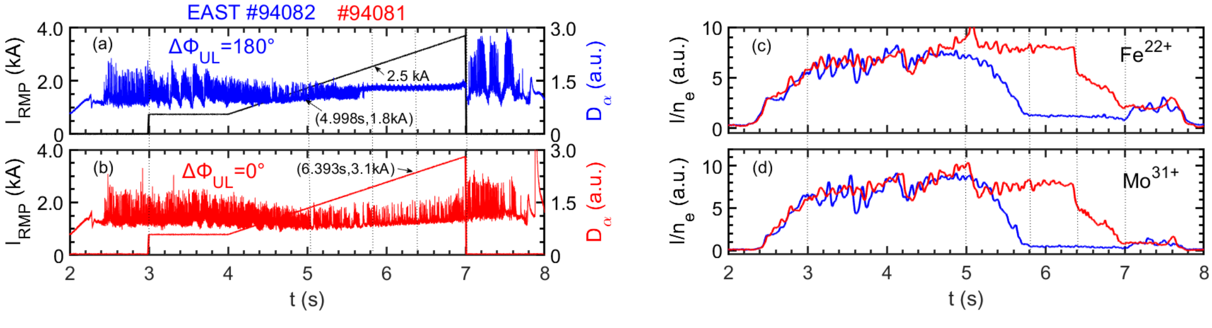

Figure 1. RMP coil current rump up of n=2 in EAST #94082 (blue) and #94081 (red) discharge (a) RMP coil current and D_α emission of #94082, (b) RMP coil current and D_α emission of #94081, (c) Fe^{22+}, and (d) Mo^{31+} radiation normalized by line averaged electron density.