SIMULATION STUDY ON TUNGSTEN FIRST WALL EROSION AND IMPURITY TRANSPORT IN EAST TOKAMAK

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Plasma-facing components (PFCs) are directly exposed to high-temperature plasma environments, and tungsten (W) becomes to the main candidate of PFCs due to its high melting point, low sputtering rate, and low tritium retention. However, due to its high atomic number (Z=74), W induces significant radiative energy losses in the core plasma, leading to a substantial reduction in plasma temperature, making it highly incompatible with the core plasma. Therefore, the erosion and transport of W impurities are critical issues in nuclear fusion.

The generation of W impurities at the divertor target and their transport in the divertor region have been extensively studied. The particle flux and temperature variations of the target plate, caused by impurity injection in radiative divertors, are key factors affecting W target erosion [1,2]. Additionally, drift effects and the location of impurity stagnation points are crucial factors influencing the impurity screening capability of the divertor [3]. However, simulation studies on W impurity erosion and transport from the first wall remain insufficient, mainly due to the challenges in extending plasma simulations to the first wall.

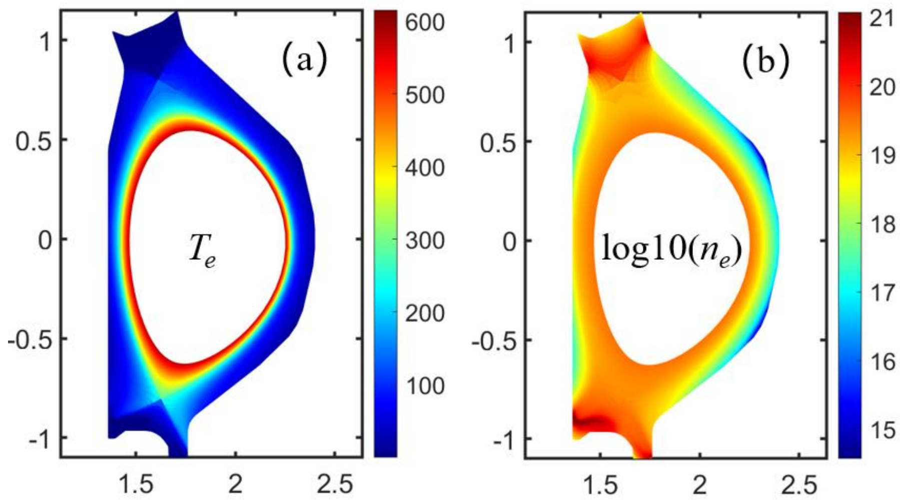

Fig 1. (a) T_e and (b) n_e simulated by extended-grid version of SOLPS-ITER

In this study, we investigate the erosion and transport of W impurities from the first wall using the extended-grid version of SOLPS [4] (Figure.1) and the IMPEDGE impurity transport code [5] (Figure.2). To better simulate first-wall erosion, the IMPEDGE code has been enhanced to include the impact of neutral particles generated by charge exchange reactions on wall erosion. The study employs background plasma with different neon injection rates, focusing on the comparison of W impurity erosion and transport behavior between the divertor target and the first wall. The results indicate that, unlike the divertor target, the first wall does not directly experience intense energy and particle fluxes; its erosion primarily originates from high-energy neutral particles generated by charge exchange reactions and the impact of highly charged impurity fluxes. Furthermore, the study quantifies the contributions of both the divertor and the first wall to core tungsten impurity concentrations under different discharge conditions.

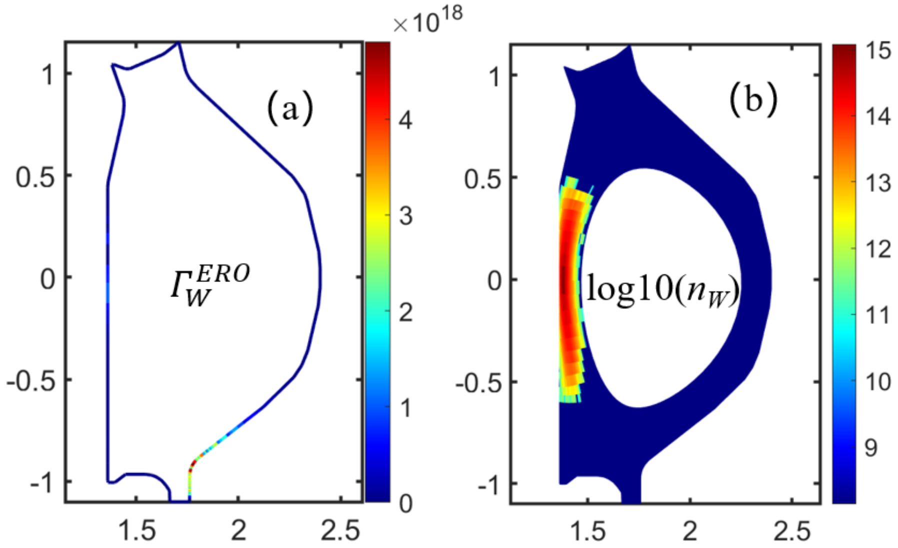

Fig 2. (a) W impurity erosion source and (b) Test particles transport in the background plasma by IMPEDGE

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