Charge-exchange neutral flux to the first wall on EAST and its implications for ITER

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As the run time and energy load on the first wall (FW) in ITER are much higher than the present tokamaks, the FW erosion rate will increase significantly even by several orders of magnitude. In addition to plasma ions, charge exchange (CX) neutrals in ITER will play an important role on the first wall erosion and overall fuel retention, but the extent to which they contribute needs to be clarified. Therefore, it is essential to know the generation mechanism of CX neutrals, and also the fluxes, energy and angular distributions of the CX neutrals on the first wall.

A set of new diagnostics on EAST, low energy neutral particle analyzer (LENPA) and quartz crystal microbalance (QMB) help to understand the neutral behaviour in different plasma conditions and also the neutral-induced material erosion rate. A new LENPA system based on the time-of-flight method has been developed on EAST to measure the neutral flux to the first wall in the energy range of 20–3000 eV. For the H mode discharges, the slope of neutral energy spectrum at low energies is steeper, and flatter for high energies than in the L mode discharges. The neutral energy spectrum is strongly influenced by fueling and edge plasma conditions. The measured neutral energy spectrum is modelled using the edge fluid SOLPS-ITER code. The neutral flux to the wall is strongly dependent on the local neutral gas density, which is determined by the local recycling sources and external fueling. Meanwhile, a quartz crystal microbalance (QMB) was installed close to the LENPA system on the equatorial port of EAST for in-situ measurements of erosion and deposition rates. The measured material erosion rates by CX neutrals are well explained by the calculations using the neutral energy spectrum measured by a new low-energy neutral particle analyzer (LENPA). It is proved that higher density and heating power can increase the flux and energy of neutral particles, which results in stronger neutral-induced material erosion. Based on the neutral measurements on EAST, a scale of the neutral flux to ITER is developed, which help to make more reliable predictions on the FW erosion and fuel retention.