Application of merging/reconnection heating for spherical tokamak in MAST

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The world largest application of merging/reconnection heating, which was developed in START [1] and TS-3 [2], has been studied in detail using 130 channel YAG- and 300 channel Ruby-Thomson scattering measurement and a new 32 chord ion Doppler tomography diagnostics [3] in MAST. In addition to the previously achieved record heating of ~1keV [4], it is found that magnetic reconnection mostly heat ions globally in the downstream region and electrons locally in the X point by 2D imaging measurement of ion and electron temperature profile [5]. Electrons mostly gain energy around X point with the characteristics scale length of 0.02-0.05m < c/ω_{pi}, while ion temperature increases inside the acceleration channel of reconnection outflow with the width of c/ω_{pi} ~ 0.1m and the downstream where reconnected field forms thick layer of closed flux surface. The toroidal guide field mostly contributes to the formation of a localized electron heating structure at the X point and not to bulk ion heating downstream. The global reconnection heating of ions increases as a function of poloidal magnetic field B_p^2 by outflow heating mechanism. In the millisecond time scale startup experiment in MAST, the energy relaxation time between ions and electrons is in the comparable time scale (τ^E_{ei} ~ 4-11ms) and electrons are also heated globally after the delay of τ^E_{ei}, forming triple peak structure with the hot spots at the X point and downstream both with and without the assist of centre solenoid.

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