Observation of divertor peak heat flux reduction by turbulence during the inter-ELM and ELM-free phase in NSTX

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Recent research indicates that the midplane Scrape-off Layer (SOL) power fall-off length (λ_q) for ITER is expected to be very narrow, ~1mm, for the baseline inductive H-mode burning plasma scenario at I_p=15MA [1]. This result is consistent with the prediction from a heuristic drift-based theory [2]. However, turbulence effect has not been considered in the heuristic model and it is important to develop a more comprehensive understanding of physical processes that determine λ_q. In NSTX, filamentary structure in heat flux profile, suspected to be induced by turbulence blob, is observed during the inter-ELM and ELM-free phase for many H-mode discharges. The filamentary heat flux structure varies in time; beginning to deposit heat onto the near SOL and then further out to the far SOL at a later time during the cycle. In the beginning of ELM-free phase, the heat flux profile is narrow and no filamentary structure is observed. With the appearance of blob turbulence, the heat flux width increases by ~100% with total power deposited to the divertor surface almost constant. This results in the reduction of peak heat flux (q_{peak}) by >50%. Filamentary structure in heat flux profile is often observed during the inter-ELM periods and this leads to the reduction of q_{peak} by ~50% compared to that during the no-blob ELM-free phase. The temporal evolution of filamentary structure is consistent with the gas-puff imaging (GPI) diagnostic data. Detailed data analysis for the physical processes of heat deposition by turbulence blobs with a range of operating parameters from NSTX will be presented. This work was supported by the US DOE, contract number DE-SC0008309.

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