Simulation of ELMs and impurity plasma transport in SOL

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ELMy H-mode is one of the operational scenarios foreseen for ITER. Good confinement and a high thermonuclear plasma density associate usually with Type I ELMs, which, however, will have a severe plasma impact on the divertor armour in ITER. Modern tokamaks do not produce ELMs powerful enough to damage the divertor but anticipated type I ELMs in ITER dump 1-3 MJ/m^2 onto the divertor armour during 0.1-0.5 ms. Such heat loads will vaporize the carbon fibre composite (CFC) being now the reference material for the ITER divertor armour. Vaporized armour material is ionised by impact plasma stream and expands along the magnetic field lines. The alternative armour material, tungsten vaporises also at such heat loads, albeit the density and the mobility of tungsten plasma is much smaller in comparison with those of the carbon plasma.

Anticipated scenario of hot core plasma contamination by divertor material plasma includes longitudinal transport and penetration of the impurities into the confinement region. After relatively fast occupation of SOL, the impurity diffuses across the magnetic surfaces to the pedestal region and further to the core and cools down the thermonuclear DT plasma irradiating its energy. At this stage the material plasma penetrates in the core and can run the tokamak into disruption.

First estimation of SOL plasma contamination by the target material has been performed earlier [1]. Large carbon plasma density up to ~10^{15} cm^{-3} in SOL was obtained. This paper describes the results of numerical simulation of core plasma radiation cooling rate by the impurity using a phenomenological scenario for ELM. Injection of the thermonuclear plasma across the magnetic field into SOL during ELM is simulated by artificial increase of the diffusion coefficient in a thin layer of plasma in pedestal and SOL close to the separatrix.

References

[1] http://eps2004.clf.rl.ac.uk/pdf/P1_135.pdf