Plasma pollution in ELMs caused by redeposited carbon at the divertor surface

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As expected for the ITER tokamak operating in ELMy H-mode, one giant ELM of type I will dump a significant part of confined plasma at the divertor armour depositing the energy of 1–3 MJ/m^2 during 0.1-0.5 ms. This energy load causes armour surface vaporization. A cloud of ionised vapour of the temperature of a few eV expands and propagates towards the x-point and further in SOL, substantially polluting the confined plasma and causing the radiation collapse. For the CFC armour, previous estimations of the plasma pollution taking into account the 'hot spots' at the surface resulted in the tolerable ELM energy deposition E_{ELM} lower than 0.3 MJ/m^2, which requires significant mitigation of the H-mode.

The aim of this work is to estimate an additional constraint for E_{ELM}. The vaporization is assumed be enhanced due to a surface layer of redeposited carbon in which the thermal conductivity is much lower compared to the bulk armour material. The small thermal conductivity of the redeposited layer of a few ten of micrometers thickness significantly increases surface temperature and thus the vaporization flux. As the result, it is shown that E_{ELM} should be much less than the value for the pure armour material.

The dynamics of vaporized armour material is simulated with the two-dimensional MHD code FOREV-2 containing a detailed radiation transport feature. The results of numerical calculations are compared with analytical estimations of E_{ELM}. Experimental evidences for the carbon redeposited layers and the layer properties are discussed.

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