Contributions of vapor shielding at metal walls to the erosion suppression during transient events

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Erosion during transient events largely reduce the lifetime of plasma facing components. As demonstrated by studies for carbon walls, vapor shielding can inherently suppress the erosion, but its efficiency is not fully predictable. For the ITER operation, the transient loads with an unseen-scale energy density and a long-time scale will be applied to metal walls. Then, following questions arise.

・What is the efficiency of vapor shielding? and how does it depend on the energy density, pulse length, and temporal pulse shape?

・Will static or dynamic equilibrium condition be achieved between the incoming plasma flux and wall?

Experiments by linear devices including plasma guns are answering these questions. Existing of the equilibrium condition is indicated by two experimental findings; saturating erosion rates as energy density increases [1] and oscillating surface temperature during shielding observed at a low melt-point metal [2].

Further physical understandings are achieved using a PIC-based vapor shielding code, recently developed by the authors [3]. In addition to the energy dissipation by radiation cooling considered in conventional fluid models, importance of ion-neutral collisions is pointed out. Using the code, vapor shielding of several pulse scenarios are analyzed and strong dependence of shielding efficiency on the temporal pulse shape is being revealed. On-going studies for the ITER VDE scenario, the equilibrium conditions in a longer pulse and the vapor shielding efficiency as a function of surface temperature will also be discussed.

Erosion during the transient events needs to be summarized before the start of ITER operation. In this talk, precisions required for the erosion estimation and remaining tasks for the vapor shielding will be discussed.

[1] V. I. Tereshin *et al., Plasma Phys. Control. Fusion* 49 (2007) A231–9
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[3] K. Ibano *et al.*, *Nucl. Fus*ion, 59 (2019) 076001