Erosion simulation of first wall beryllium armour under ITER transient heat loads

B. Bazyleva, G. Janeschitza, I. Landmanb, S. Pestchanyib and A. Loartec

aForschungszentrum Karlsruhe GmbH, FZK, P.O. Box 3640, D-76021 Karlsruhe, Germany
bFZK-Forschungszentrum Karlsruhe, Association Euratom-FZK, Technik und Umwelt, Postfach 3640, D-76021 KARLSRUHE, Germany
cEFDA Close Support Unit Garching, Boltmannstr.2, D-85748 Garching bei München, Germany
bazylev@ihm.fzk.de

Operation of ITER at high fusion gain is assumed to be the H-mode. A characteristic feature of this regime is the transient release of energy from the confined plasma onto divertor and the first wall by multiple ELMs (about $10^4$ ELMs per ITER discharge), which can play a determining role in the erosion rate and lifetime of these components. It is expected that about 50-70% of the ELM energy releases onto divertor armure and the rest is dumped onto the First Wall (FW) armour. The expected energy heat loads on the ITER divertor and FW during Type I ELM are in range 0.5 - 4 MJ/m² in timescales of 0.3-0.6 ms. In case of the ITER disruptions the material evaporated from the divertor expands into the SOL and generates significant radiation heating of the FW armour up to several GW/m² during a few milliseconds that can also lead to the its melting and noticeable damage.

Beryllium macrobrush armour (Be-bruhes) is foreseen as plasma FW facing component (PFC) in ITER. During the intense transient events in ITER the surface melting, melt motion, melt splashing and evaporation are seen as the main mechanisms of Be-erosion. The expected erosion of the ITER plasma facing components under transient energy loads can be properly estimated by numerical simulations using the codes MEMOS and PHEMOBRID validated against experimental data obtained at the plasma gun facilities QSPA-T, MK-200UG and QSPA-Kh50 that provide a way to simulate the energy loads expected in ITER in laboratory experiments.

The numerical simulations were carried out for the expected ITER ELMs for the heat loads in the range 0.5 - 3.0 MJ/m² and the timescale up 0.6 ms and ITER disruptions for the heat loads in the range 2 - 13 MJ/m² in timescales of 1-5 ms. Radiation heat loads at the FW armour from the vapour expanded into the SOL were calculated using the codes FOREV-2 and TOKES for both ITER ELM and ITER disruption scenarios. Melt layer damage of the Be FW macrobrush armour under radiation and expected plasma heat loads was simulated using the code MEMOS.