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Melting of Tungsten by ELM Heat Loads in the JET Divertor

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Our priority for the 2013 JET campaigns was to provide relevant data for the ITER decision on whether to initially install a full tungsten divertor rather than a design with carbon at the strike points. A key element of this was an experiment using a specially modified divertor module which was used to study the characteristics and impact of ELM induced melting of bulk tungsten on JET operation –JET is currently the only machine with ELMs large enough to perform such experiments. A series of discharges at 3MA plasma current and 23MW of input power were used and resulted in parallel power densities of ˜3GWmˆ-2 during ELMs and ˜0.5GWmˆ-2 between ELMs. A ˜2mm vertical step in a not normally used part of the divertor was exposed to this heat load for up to 1.5s.
Melting was achieved in series of 7 identical discharges and the depth of material moved/removed on each pulse was very reproducible, at least an order of magnitude less than would be expected from bulk tungsten melting and equivalent to ⊠ 10microns per ELM. Tungsten droplets formed and migrated along the exposed edge to the private region driven by jxB forces. The impact on main plasma was negligible with no disruptions. Small spikes in spectroscopic tungsten signals were observed and suggest occasional ejection of droplets with effective radii of at least 80microns.
The JET results provided very positive support for the ITER decision to start with an all W divertor and provide a valuable benchmark for the transient induced melt layer models used by ITER. Significant progress has been made in reproducing the thermal and melt behaviour seen in JET using the MEMOS code.

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