Characterization of runaway electron wall damage in DIII-D*

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Experiments in DIII-D are studying post-disruption runaway electron (RE)-wall impacts to allow eventual prediction of potential damage to plasma-facing armour in ITER. Strikes on the graphite centre post provide global characteristics, while strikes on a graphite dome sample are used to explore details of the RE-material interaction in a controlled, well-constrained setting. Modeling is performed using MARS-F for MHD structure and KORC for simulation of RE orbits; while GEANT4 and COMSOL Multiphysics codes simulate energy deposition and thermomechanical response. The global wetted area depends strongly on the impurity level; low impurity RE beams are deposited over larger wall areas than beams with high impurity content. This is also found to correlate well with final loss instability MHD amplitude. Wall damage and material explosion is observed to result from sudden sub-surface (~ 1 mm) heating of plasma-facing components. Impact angle of the incoming REs is found to be important, with incorrect assumptions about the impact angle observed to cause mismatches between simulations and observed material damage. Both simulations and experiment indicate that RE energies are not strongly modified during the final loss process to the wall, but there is some indication that RE pitch angles can be increased. Increasing pitch angle can be expected to cause less damage to near-surface material, but could result in increased damage risk to sub-surface structures.

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