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EX/4-2: Comparison of Plasma Breakdown with a Carbon and ITER-like Wall

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The standard method to initiate plasma in a tokamak is, to ionize pre-filled gas by applying a toroidal electric field via transformer action from poloidal coils. For ITER the available electric field will be limited to low values of 0.33V/m, raising considerable interest to understand and optimise the plasma breakdown process.
At JET un-assisted breakdown has previously been achieved at electric fields as low as 0.23V/m though with carbon plasma-facing components. It is well-known that impurities can have a impact on the breakdown process. The recent installation of a full metal, ITER-like, first wall provided the opportunity to study the impact of the plasma-facing materials on breakdown. This study will present for the first time a full experimental characterisation of tokamak breakdown at JET, using all discharges since 2008, covering both operations with a main chamber carbon and beryllium ITER-like wall.
It was found that the avalanche phase was unaffected by the change in wall material. However, the large reduction in carbon levels resulted in significant lower radiation during the burn-through phase of the breakdown process. Breakdown failures, that usually developed with a carbon wall during the burn-through phase (especially after disruptions) were absent with the ITER-like wall.
A new model of plasma burn-through including plasma-surface interaction effects has been developed. The simulations show that chemical sputtering of carbon is the determining factor for the impurity content, and hence the radiation, during the burn-through phase for operations with a carbon wall. For a beryllium wall, the plasma surface effects do not raise the radiation levels much above those obtained with pure deuterium plasmas, similar as seen in the experimental study discussed above.

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