An insight on the beryllium dust sources in JET ITER-like wall based on numerical simulations

A. Uccello

Istituto di Fisica del Plasma, CNR, Milan, Italy

Tokamak experiments approaching thermonuclear conditions, like ITER, must face seriously the safety issues related to the release of debris in dust or droplet form from the vessel first wall. In case of loss-of-vacuum accidents, there is a safety hazard due to remobilisation of inhalable toxic or radioactive dust accumulated during operation. For this and other reasons, the investigation of the sources and the collection of dust in JET with the ITER-like wall (ILW), supported by a systematic modelling of dust transport, is a crucial task for ITER.

In JET-ILW, experimental observations have provided evidence that molten particle ejection from the beryllium (Be) upper dump plates (UDPs) during unmitigated vertical displacement events (VDEs) is the main source of dust and debris.

This work presents a first realistic assessment of the migration and redistribution of particulate of metallic Be and composites in the JET vessel, mobilized during a typical unmitigated VDE from the UDPs. The investigation is based on real observations and is carried out by means of the numerical code DUSTTRACK, which provides full information on the dynamic and thermodynamic history of the debris. The general objectives, basic assumptions and physical model of DUSTTRACK are discussed with an eye also to those of the other dust transport codes developed in the fusion community. With the aim of connecting the dust post-mortem data with the dust source, both qualitative and semi-quantitative statistical descriptions are provided to establish the dependence of the dust deposition (state, location, size, impact speed) on the initial conditions. The focus is here given to the comparison between the output of DUSTTRACK and the experimental data from the UDPs weighting and photographic survey and from the dust collection techniques. The numerical results show consistency with observations. In particular, most of the simulated droplets impinge on the surface of near-by tiles as shown by the camera images of the upper part of JET vessel. Moreover, in agreement with the very low density of particulate found into the dust collection systems placed just above the inner and outer divertor, DUSTTRACK predicts that a small percentage of the simulated particles can reach the collectors position.

In outlook, numerical calculation with DUSTTRACK can help choosing the positioning of dust collection systems. Furthermore, confidence is gained that predictive modelling can give support to scenario development for the next deuterium-tritium JET operation.