Dust in tokamak and related safety open issues.

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During fusion machine operation and due to plasma wall interaction, particles/dust will be created (size ranging from nanometer to tens of micron). Different morphologies of dust are expected to be produced from spherical particles induced by melting of metal after high heat flux interactions (unipolar arcs, ELMs,...) to fractal ones created by accretion. The later point is confirmed by dust collection in a full tungsten (W) environment machine, the WEST tokamak. Indeed, among the collected particles, spherical and complex shape submicron-sized ones are found. Their high specific surface area can be associated with high physico-chemical reactivity.
The first part of this presentation will be devoted to describe the processes of powder creation in fusion machines. It will also be recalled how the production of powders is currently estimated according to the processes involved. A critical analysis of the results predicted for the future fusion machines (ITER and DEMO) will be made, focusing in particular on the creation processes that may have been neglected due to the different plasma operation of the current machines.
The consequences of the presence of these tritiated and activated dust in the tokamak on the safety of the machine will be then detailed.
In the rest of this presentation we will focus on the study of relevant W tritiated particles.
Experimental results of tritium loading/desorption carried out on W particles having a wide range of surface topology will be recalled.
These experimental results are reproduced by using a kinetic surface model suggesting that the bulk contribution is very low for such particles. With this approach, the desorption kinetic is explained by the change of the desorption energy with the coverage of the surface by hydrogen which is highlighted by atomistic simulations: on bare surface, the desorption energy is 1.4 eV while for saturated surface, it drops below 0.8 eV.
This approach has numerous experimental consequences that will be described in detail in the presentation.
It will be shown, especially, that W dust placed on the bottom floor of a fusion machine and exposed to tritium gas will be loaded with tritium even at very low in vessel tritium pressure. Surface saturation can be reached rapidly at 1 Pa and 373 K. How the trapping on W massive material can be modified by the presence of fuzzy structure will be also addressed.
However, this saturation can be mitigated by isotopic exchange. Tritiated dust exposed to D_2 or H_2 at 300-373 K will lose their total quantity of tritium as soon as the H_2 or D_2 are the main isotopes in the vacuum vessel.
Some consequences of these observations will be discussed in terms of safety for the machine. Especially, we will investigate if this capacity to release tritium modifies the approaches that must be followed in the analysis of a LOVA (Loss Of vacuum Accident). Consequences expected on the measurement of tritium carried by dust and the evaluation of the tritium source term will be also reviewed.