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Trap-diffusion modelling of diffusion in restricted geometries

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Trap-diffusion modelling is of fundamental importance for the analysis of plasma-material interaction experiments (e.g. to extract information about hydrogen isotope trapping energies using thermal effusion spectroscopy) and is also indispensable to estimate tritium retention/permeation in future fusion devices.

Thus in the recent years a number of simulation codes have been developed (e.g. TESSIM-X, MHIMS, TMAP8, RAVETIME, FESTIM), all implicitly relying on the mathematical assumption of an underlying 3-dimensional random walk based transport process. However, in many cases of practical interest this assumption may not hold. For example, hydrogen permeation experiments on tungsten foils, evaluated using hydrogenography have shown the importance of hydrogen transport along grain boundaries. The geometric properties (i.e. the aspect ratio) of typical grain boundaries (e.g. in tungsten) suggest that a 2-d random walk is better suited than a 3-d random walk model to describe the hydrogen transport in grain boundaries.

The consequences for the transport properties and how the macroscopic trap-diffusion equations have to be modified to account for diffusion in restricted geometries are presented.

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