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Temperature dependence on retention of hydrogen isotope in tungsten material
タングステン材料中水素リテンションの温度依存性

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The ACAT-DIFFUSE code has been modified so as to calculate the amount of retained hydrogen isotopes in wall material under exposure to high heat flux of edge localize mode (ELM). The temperature gradients near the surface of wall materials due to ELM condition are calculated by the one dimensional finite element method (FEM). The effect of the temperature gradients of wall materials for the retention of hydrogen isotopes has been calculated with the ACAT-DIFFUSE code which includes heat transfer calculation as a subroutine.

1. Introduction

Wall materials in a fusion device are exposed to intense bombardments of energetic hydrogen isotopes and high heat flux as observed in edge localized mode (ELM). They lead to the retention of hydrogen isotopes and at the same time cause large temperature gradient near the surface in wall materials. The resulting temperature gradient due to high heat flux should largely alter the transport of hydrogen isotopes in wall material, which affects the amount of retained hydrogen isotopes. To realize the capability for clarifying the effect of the temperature gradient due to high heat flux for the retention of hydrogen isotopes, the dynamic Monte Carlo simulation code ACAT-DIFFUSE [1] have been modified and used under ELM conditions.

2. Calculation model

The ACAT-DIFFUSE code has been used to calculate the amount of retained hydrogen isotopes in wall material but with homogeneous temperature profile so far. The ACAT-DIFFUSE has been modified to take into account of the diffusion and trapping of hydrogen isotopes under ELM condition by including subroutines of heat transfer calculation based on the finite element method (FEM).

3. Result

Figure 1 shows the amount of deuterium atoms retained in tungsten during a time sequence of l00 eV D^+ bombardment with temperatures 300 K and 473 K calculated with ACAT-DIFFUSE under the homogeneous temperature model. The calculation results have indicated the amount of retained hydrogen isotopes in tungsten at 300 K is larger than that at 473 K. The increase of trapped hydrogen isotopes in tungsten at lower temperature results in the enhancement of the amount of retained hydrogen isotopes compared with that for higher temperature. The temperatures of target materials play a decisive role for the retention of the isotopes in wall materials.

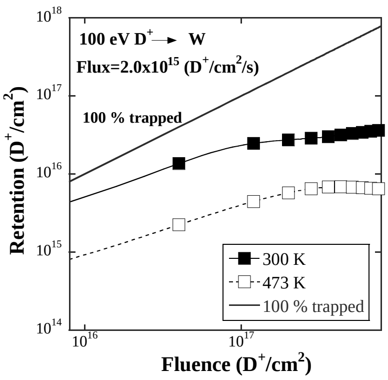

Fig. 1. Amounts of deuterium atoms in tungsten at 300 K and 473 K

4. Discussion

The large temperature gradient near the surface of wall materials due to high heat flux of ELM condition requires inclusion of a subroutine to calculate the precise temperature gradients of wall materials for accurate calculation of the retention of hydrogen isotopes during a fusion device operation. The one dimensional FEM method is applied to calculate the temperature gradients of wall materials for the ACAT-DIFFUSE code. The amount of trapped hydrogen isotopes and diffusion of the isotopes in wall material are largely modified due to the temperature gradients compared with those under a homogeneous temperature model. These changes directly affect the amount of retained hydrogen isotopes in wall material. The effect of the temperature gradients near surface of wall materials for retention of hydrogen isotopes has been calculated with ACAT-DIFFUSE. Some initial results of the code will be introduced.

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References

[1] Y. Yamamura: Nucl. Instrum. Meth. **B28** (1987) 17.