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Ionizing radiation effects on the thermal stability of deuterium trapping in SiC

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Keywords: Deuterium absorption, displacement damage, deuterium implantation, ionization irradiation, desorption, trapping.

Highlights:

Ionizing radiation increases the deuterium absorption

Deuterium release enhancement due to ionizing radiation

Displacement damage resulting in an increment of formation of Si–D bonds

Abstract

SiC materials are prime candidates for flow channel inserts in the dual coolant lithium lead blanket concept. Flow channel inserts made of SiC will be exposed to tritium from the Li transmutation, as well as to neutron and gamma radiation. Hence a critical issue for future fusion devices is to clarify hydrogen isotope behaviour in SiC under such conditions. The objective of the work presented here is to study the effect of ionizing radiation on the deuterium trapping in SiC in similar conditions as reactor materials. This effect is evaluated by studying the influence of ionizing radiation on deuterium trapping (for both implanted and loaded SiC samples). Moreover, it is investigated how deuterium trapping may be modified by displacement damage. The ionizing radiation effect on absorption has also been evaluated for samples pre-damaged by self-ion irradiation. The irradiation and implantation experiment have been carried out at the CMAM-UAM accelerator, and the Danfysik implanter and 2 MeV Van de Graaff electron accelerator at CIEMAT. Samples are analysed by thermal desorption spectroscopy and secondary ion mass spectrometry (SIMS) to clarify the mechanisms involved in the trapping processes, depending on the different experimental conditions. The results for the deuterium loaded samples indicate that absorption is increased by ionizing radiation. When samples are pre-damaged by C^{+4} ions, deuterium absorption is increased in the form of Si-D according to SIMS results. Furthermore, the effect of ionizing radiation after deuterium implantation is an enhancement of the deuterium released from SiC. The deuterium release observed in this case is forming hydrocarbons during irradiations.