

Temperature Dependence of the Deuterium Concentration in Silicon Carbide Codeposits

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In magnetic confinement fusion devices, codeposition of hydrogenic species in first wall materials poses a number of engineering problems. In particular, tritium retention in codeposits can represent a major loss to the tritium inventory and can introduce difficulties in controlling fuel density. In addition to this, large tritium codeposits can pose a safety risk due to high levels of radioactivity.

For the proposed AIRES-AT powerplant design, silicon carbide was chosen as the first wall material for its high-temperature capabilities, low effective Z , and advantageous neutron irradiation properties [1,2]. There have also been recent experiments with SiC-coated tiles in the DIII-D tokamak [3]. While ceramic plasma-facing materials have the advantage of much higher operating temperatures than metals, hydrogen retention in carbon-based codeposits has been seen to be significantly higher (up to 50 atom-percent) as compared to metallic first wall materials [4]. Experiments comparing the hydrogen retention of silicon carbide subjected to direct implantation show that the retention for silicon carbide under these conditions is similar to that of graphite [5]. However, only minimal information [6] is currently available on the hydrogen content of silicon carbide codeposits, and no temperature dependence has yet been established.

In the current experiments, codeposits, 50 to 1000 nm thick, are formed on heated tungsten substrates by sputtering silicon carbide with a deuterium ion beam. The resulting deposits are then analyzed using Thermal Desorption Spectroscopy (TDS) to determine the total deuterium content, as well as the temperature profile of the released species (eg., D_2 , CD_4 , etc.). The deposit thicknesses are determined by mass gain, surface profilometry, AFM and SEM measurements. The same procedure will be repeated with a graphite target so that a direct comparison can be made between pure carbon and SiC codeposits.

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