A study on carbon and hydrogen transportation to exhaust systems and sticking behavior

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Graphite materials have been used as plasma facing materials in fusion devices. As a consequence, tritium accumulation in carbon deposits has been recognized as an important issue for a fusion reactor from viewpoints of fuel cycle and radiation safety. In ITER and other fusion devices such as LHD, nevertheless, carbon based materials are used in the divertor region. Therefore it is necessary to develop understandings of deposition processes and transportation behaviors of tritium and carbon. This study focuses on carbon and tritium transportation at the outlet region of plasma.

The mixture gas of hydrogen and methane was introduced into a quartz reaction tube and plasma was generated in the tube by the inductive coupling method. Beforehand several quartz chips were set in the vicinity of the outlet of plasma in line. Some of carbon based particles, which are generated by plasma decomposition of methane, stuck on quartz chips. The amount of carbon based deposits including hydrogen was estimated from the weight change of the quartz chips before and after the experiment. The amount of hydrogen contained in the deposits was measured by the thermal desorption method in argon atmosphere. Components of the plasma outlet gas were monitored by the quadrupole mass spectrometer.

A large amount of the deposit was observed in the region only where the plasma density declines gradually. The values of H/C in the deposits varied in the range from 0.01 to 0.2 depending on the place of deposition. From components of the plasma outlet gas, the weight of deposits and total amount of input methane, carbon mass balance was considered. It was found that 0.2 % of the carbon atoms that were included in the methane decomposed in plasma was converted to hydrocarbon such as C_2H_2, and 10 % stuck as deposits, and other around 90 % was transported to exhaust systems. This result suggests that nonnegligible amount of tritium may be accumulated with carbon on piping and pumps in exhaust systems of a fusion reactor.