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TOPIC: H - Fuel Cycle and Breeding Blankets

Flexible small size radiofrequency plasma torch for Tokamak wall cleaning (P4-H-437)

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Tritium accumulation in walls is a limiting factor in efficient long term operation of fusion machines. A number of detritiation techniques are under study, like laser, discharge, flash lamp based cleaning. One of the encountered difficulties is the limited access of the detritiation tool in narrow spaces, as in divertor region, inter-tiles or inside castellated gaps, where in fact an enhanced co-deposition and tritium trapping were observed. This contribution addresses the problem of elaboration of plasma torch as a tool appropriate for stimulating detritiation and removal of co-deposited layers in such spaces.

The requirements imposed to the plasma torch source were related to the compatibility with inside torus operation: small diameter in order to permit access in narrow spaces, reasonable power, large range of working pressures from vacuum to atmosphere, closed loop cooling, flexibility in order to allow scanning and mounting on a robotic arm. The approached design is based on a radiofrequency discharge constricted to burn in a closed space between an active radiofrequency electrode and a grounded nozzle, from where plasma expands outside as a directional beam. The found solutions have led to a flexible hand held source working stable up to 300 W injected power and consisting of a cylindrical body of 20 mm diameter including the external water jacket embracing the discharge and an inside cooling circuit.

The electrical characterization of the radiofrequency discharge sustaining the expanded plasma was performed and the domain of stable source operation in terms of power, current, pressure, argon mass flow rate is presented and discussed. The plasma beam size presents a strong dependence on pressure: the plasma length decreases from 200 mm to 20 mm, when pressure increases from vacuum to atmospheric, depending on power and mass flow rate. The ionized gas temperature, as indicated by a thermocouple head inserted in expansion in the nozzle proximity fall in the range 500-1000 oC. Emission spectroscopy, applied to preliminary experiments of scanning graphite and metallic surfaces with the plasma torch in open atmosphere, indicates that processes like gaseous radicals desorption are activated, the rate depending on the surface nature. The use of active gases is envisaged in order to enhance the observed effects.

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