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Deuterium and helium retention in tungsten based materials exposed to plasma

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Tungsten and dense nano-structured tungsten (W) coatings are used as plasma-facing materials in current tokamaks and [A1] suggested to be used also for the future fusion devices, ITER and DEMO. In the fusion reactor, W will be exposed to energetic particles of hydrogen isotopes and helium (He), high heat flux and neutrons. In this regard, a study of accumulation of deuterium (D) and He in W under normal operation conditions and transit events is necessary for assessment of safety of fusion reactor due to the radioactivity of tritium and material performance and for the plasma fuel balance. Therefore, W samples were exposed to low-temperature plasma to simulate normal operation regimes and pulsed heat loads using D plasma in quasi-stationary high-current plasma gun QSPA-T to simulate transit events. We found that D and He concentrations increased with decreasing the grain size. The D retention was the highest for samples irradiated by plasma gun above the melting threshold. The D retention after 10 pulses of plasma gun exposure was much higher than that after stationary low-energy plasma exposure at sample temperature of either 600 K or 700 K indicating the dominating influence of ELM's-like events on the D retention compared to normal operation regime. The D retention in W samples with the presence of He-induced W fuzz was smaller than without that. The results obtained gives possibility to assess the particle retention in diverter areas subjected to high thermal loads at different operation regimes.

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Estimation of bubble fusion requirements during high-pressure, high-temperature cavitation

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Taleyarkhan's group at Oak Ridge National Laboratory (USA) have claimed to have found evidence of nuclear fusion in a beaker filled with an organic solvent subjected to ultrasonic irradiation. The bubbles produced by UC, a technique commonly employed in sonochemistry, are typically several micrometers in size, and their collapse can generate microjets with temperatures of several thousand degrees Celsius. In contrast, bubbles produced by water jet (or liquid jet) cavitation methods, such as floating cavitation, are several hundred micrometers in size, and their collapse produces microjets with high pressures of approximately 1.0 GPA. For many years, fusion reactions have been used to raise the temperature of plasmas to investigate several aspects of this state of matter, including the external energy required to increase the temperature of plasma, the conditions of plasma at its critical point, and deuterium–tritium (D–T) reactions. It has been found that, for nuclear fusion to occur, it is necessary for the original nuclei to collide at a speed of over 1.0×103 km/s. Thus, the nuclei must experience a pressure of 1.0×1011 atm and a temperature of 1.0×108°C. In the present study, a new cavitation method termed multifunction cavitation (MFC), which combines the characteristics of both UC and water jet cavitation, was applied to the study of bubble fusion. The cavitation velocity and the pressure and temperature inside a bubble in deuterated acetone when employing MFC were estimated theoretically and compared to the values required for fusion. During MFC, as the bubble shrinks to 100 to 0.1 μm, the pressure and temperature inside the bubble drastically increase, possibly leading to temperature and energy density that satisfy the conditions of bubble fusion.

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