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EX/P5-08: Impact of Arcing on Carbon and Tungsten: from the Observations in JT-60U, LHD, and NAGDIS-II

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Arcing is a long standing plasma-surface interaction issue, and the issue is being revived recently. This paper gives warning on the impact of arcing in fusion devices based on the observations in JT-60U, LHD, and the linear divertor simulator NAGDIS-II. From the analysis of arc trails on carbon baffle plate of JT-60U using a laser scanning microscope, it was found that eroded depth was several tens of micrometers in some parts, where the deposited layer seemed to be peeled off. Comparing the erosion by arcing to that by sputtering, it was thought that the arcing cannot surpass the sputtering for carbon based material unless arcing is initiated very frequently. In NAGDIS-II, the demonstration experiments of arcing/unipolar arcing have been conducted. In future fusion devices including ITER, materials are exposed to helium ions. In NAGDIS-II, the nanostructure tungsten exposed to helium plasma was used for the experiments. A pulsed laser (lambda=694.7 nm) was used to mimic the transient heat load while the sample was exposed to the helium plasma. The pulse width was approximately 0.5 ms, which was similar to the Type-I ELMs. From the experiments in NAGDIS-II, the necessary averaged laser pulse energy to ignite arcing was approximately 0.01 MJmˆ-2 when the nanostructure was formed on the surface by the helium plasma irradiation. Even taking into account the spikes of the laser pulse, the necessary energy to ignite arcing seemed more than one order of magnitude lower than the mitigated type-I ELMs in ITER such as 0.5 MJmˆ-2. Thus, it raises a concern that the arcing is also triggered by small plasma heat load due to the type-II or type-III ELMs in ITER if the nanostructures are formed on the surface. The nanostructured tungsten, which was fabricated in NAGDIS, was exposed to the LHD divertor plasma for 2 s. After the exposure to the LHD plasma, interestingly, the arcing was initiated even without any transient events, supporting the view that the arcing is easily initiated on the nanostructured tungsten surface. The erosion of tungsten by arcing will become an important issue in a fusion reactor, where helium fluence is significantly increased.

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