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Ecton Mechanism of Energy Load on ITER-grade Tungsten Limiter T-10 Tokamak and Forecast for ITER.

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Extreme high heat loads, both during steady state and transient events, expected on the tungsten divertor plates of the ITER facility, undertaken at Cadarache, France. In this paper nonambipolar plasma flow toward the surface, due to arcs and sparks, was investigated as mechanism of power exhaust, leading to enhanced heating of plasma facing materials (PFMs) at a very high heat load. This ecton mechanism results in the pulsed-periodic ignition of the explosive electron emission events providing high enough electron current from the wall. Unlike standard thermionic emission, such mechanism can dramatically increase electron emission and, as a result, sparks and arcs activity, leads to a surface overheating and melting. Such phenomenon have been observed in experiments on the T-10 tokamak with ITER-grade tungsten (W) poloidal limiter under a powerful plasma electron cyclotron resonance heating (ECRH) and plasma ring shifted inside. In such conditions, the interior tungsten plates of limiter were heated up to temperature exceeded 20000C, estimated local thermal load were of more than 40 MW/m2 on the plates edges, leading to surface melting. Intensive sparking and arcing, deep cracks and edge melting were observed on W tiles. Also, tiles surfaces were flood by recrystallized tungsten. All W tiles surface are covered by two crater types: deep, (with dimensions from 10 to 100 μm) and acetabuliform type (with dimensions from 0.5 - 20 μm) arranged in a 'long chains'- vacuum arcs, and a 'short chains'- vacuum sparks. The reason of such sub-μs discharges ignition can be plasma-turbulence-driven fluctuations of particle and energy flux to the plasma-modified surface. The report analyzes consequences for ITER the EEE appearance on the divertor W surface - the sharpening of SOL power width distribution, parallel to the magnetic field –⊠q; the melting of the W leading edges of divertor targets and the recrystallization of the W surface as a result of the superheated liquid metal droplets appearance. Melt tungsten can be subject to J × B force. EEE can lead to the erosion enhancement of the divertor plates. Micro-explosions lead to droplets, which, like dust particles, can effectively deliver impurities to the central region of the plasma.

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