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Characterization of liquid metals as prospective divertor materials under transient plasma loads

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High power magnetically confined fusion devices have very high heat and particle loads on the plasma facing components. Liquid metals (LM) mock-ups were proposed as alternative of full tungsten divertor for DEMO. Extrapolation of the disruptions/ELMs erosion effects obtained at the present-day tokamaks to the transient peak loads of next step fusion devices (ITER and DEMO) remains uncertain. Special investigations on material behavior at the relevant transient loads are thus very important.

Main features of plasma–surface interaction, vapor shield effects and energy transfer to LM materials are studied at different heat loads within the QSPA Kh-50 [1] and QSPA-M [2]. Repetitive plasma exposures of capillary pore systems (CPS) based Sn targets were performed at the plasma loads varied in the range 0.1–0.5 MJ/m2. Observations of plasma interactions with exposed surfaces were performed with high-speed camera. Optical emission spectroscopy in visible wavelength range in a free plasma stream and within vapor shield layer in a front of exposed LM targets have been measured at different heat loads. The plasma density in this transient layer is found to be up to ten times higher than in impacting plasma stream. It leads to the arisen screening effect for the plasma energy transfer to the surface. Calorimetric measurements of the target heat loads have shown importance of the shielding during the plasma surface interaction. Spectroscopy measurements have shown that for small energy loads the transient layer consists of the plasma stream species only, target impurities are appeared when the heat load exceeds the material melting threshold. The thickness of Sn vapor shield is less than 5 mm. Further increase of the energy load causes the development of strong vapor shield, which dominates in plasma-surface interaction

[1] V.A. Makhlai et. al. Nuclear Materials and Energy 19 (2019) 493–497

[2]. I.E. Garkusha, et. al. 2019 Nucl. Fusion https://doi.org/10.1088/1741-4326/ab1932

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