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Testing Liquid Metal/Capillary Porous System Concepts as alternative solution for the Divertor target design of a Fusion Reactor in TJ-II.

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The use of liquid metals as plasma facing components (PFCs) in a future fusion reactor has been proposed as an alternative to solid metals, such as tungsten and molybdenum among others [1]. The expected advantages for the power exhaust issues, mainly arising at the divertor target at power densities of 10–20 MWm−2, relay on the self-healing properties of liquid surfaces as well as the ability to in situ replacement of the surfaces exposed to the plasma by the effect of capillary forces (CPS design, [2]). Among the possible liquid metals (LM) presently considered as candidates for the development of an alternative solution to the Power Exhaust Handling in a future Fusion Reactor (Li, Sn, Ga), tin lithium alloys offer unique properties in terms of evaporation, fuel retention and plasma compatibility. This is the reason why this particular LM was chosen as main candidate in the US APEX project [3]. Very recently, LiSn (20-30:80-70at.%) alloys have been exposed to ISTTOK and TJ-II and very promising results on D retention and surface segregation of Li were obtained [4,5]. Motivated by these results a full campaign of comparative Li/ LiSn/Sn testing in TJ-II plasmas has been initiated. Solid and liquid samples have been exposed and a negligible perturbation of the plasma has been recorded in the Li and LiSn cases, even when stellarator plasmas are particularly sensitive to high Z elements due to the tendency to central impurity accumulation. The surface temperature of the liquid metal/CPS samples (made of a Tungsten mesh impregnated in SnLi, Sn or Li) has been measured during the plasma pulse with ms resolution by pyrometry and the thermal balance during heating and cooling has been used to obtain the thermal parameters of the LM/CPS arrangements as well as to calculate the thickness of the film interacting with the plasma. Temperatures as high as 1100K during TJ-II plasma exposure were observed for the LiSn case and hints of sputtering-enhanced evaporation were deduced from the temperature dependence of the lithium fluxes entering the plasma.
In this presentation a full account of the results obtained and their implications for the use of LM/CPS concepts in a future Fusion Reactor will be addressed. Particular attention will be given to the optimization of the thermal properties of the proposed designs.

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