Liquid metal vapour shielding in linear plasma devices

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Liquid metals used in plasma facing components are attractive for DEMO due to the liquid's ability to self-heal against erosion, immunity to most of the negative impact of neutrons and ability to go beyond conduction-only based cooling. One extension of this cooling is vapour shielding, occuring under high heat loading of the liquid-metal surface by the plasma leading to strong evaporation. In such a situation the interaction between the vapour and the plasma leads to additional energy and momentum loss which reduce the power to the surface from the plasma by these additional volumetric processes. A series of experiments carried out in DIFFER's linear devices Magnum-PSI and Pilot-PSI have explored this phenomenon in detail for the first time. These machines are able to recreate the high density ($>10^{20}$ m^{-3}) low temperature (<5 eV) conditions expected close to the partially detached strikepoints of ITER or DEMO. It was found that the surface temperature of Sn based substrates becomes locked when the plasma pressure and vapour pressure become similar, and that this temperature locking persists over a power input range of 1-20 MW m^{-2}. Due to ion-neutral friction and electron ion collisions the plasma is strongly cooled from 2-3 eV to <0.5 eV driving strong recombination. The plasma cooling and radiation leads to an overall reduction of ~one third in the conducted power. Additionally the process appears oscillatory in nature due to the mutual interaction of the thermal cooling (slow) with the plasma processes (fast). For Li similar behaviour is also observed and appears a general phenomenon which would be expected to be present in tokamaks. The talk will discuss vapour shielding for liquid metals and the needs for atomic data to give a deeper physical understanding and predictive capabilities for these processes.