Review of the experiments performed with liquid lithium and tin limiters on FTU

G. Mazzitelli[a] ,M. Iafrati[a], M.L. Apicella[a]

[a] *ENEA, Fusion and Technologies for Nuclear Safety Department, C.R. Frascati, Via Enrico Fermi 45, Frascati, 00044, Rome, Italy*

giuseppe.mazzitelli@enea.it

The use of liquid metals can improve the lifetime and reliability of plasma facing materials (PFM) because they are not subjected to erosion with dust formation and to a deterioration of their thermo mechanical properties due to intense hydrogen and helium influx and neutron irradiation as for solid materials. Possible liquid metal choices include Li and Sn. Lithium is a low Z material (Z=3), which allows for better plasma performance but its operational window is very narrow, 300<T<500 °C, to avoid strong evaporation. Tin is a high Z element (Z=50) having a large operation window due to the low vapour pressure, 300<T<1300 °C, low or negligible activation, low H retention and less safety problems in particular in combination with water cooling. Nevertheless, for tin, it is crucial to demonstrate that plasma operations are possible at a tolerable Z_{eff} value without plasma performance degradation.
Since 2006 on FTU tokamak, the possible use of liquid metals as PFM has been investigated. FTU is the first and only tokamak in the world operating with a liquid tin limiter. The compact high magnetic field FTU device can achieve a high power flux close to the last closed magnetic surface. Different limiter configurations, also actively cooled, were installed on FTU but all with the Capillary Pore System [1]. Four Langmuir probes are installed on the limiter itself to measure the density and the electron temperature close to the limiter. A fast IR-camera to monitor the surface temperature and a visible spectrometer to detect the line emissions for Li and tin are installed in a upper port looking directly to the limiter. Typical FTU plasma parameters close to the limiter are: density in the range of 0.4 ·0.8 $10^{19} m^{-3}$, electron temperature of about 10-20eV and e-folding lengths of heat loads in the range between 1-1.5cm. The liquid limiters have withstood heat loads less than 10 MW/m^2 for Li and 18 MW/m^2 for tin without any damages. Strong evaporation is present at these power levels but nevertheless no degradation in plasma performance has been observed. We have respectively estimated a maximum Li and tin concentration of about 10^{-2} and 5.10^{-4} of the electron density. These values are both compatible with reactor operations.
A review of the main results achieved and on the open points for a possible use of liquid metals as PFC in DEMO will be presented.

[1] L.G. Golubchikov, V.A. Evtikhin, I.E. Lyublinski, V.I. Pistunovich, I.N. Potapov, A.N. Chumanov J. Nucl. Mater. 233–237 (1996) 667–72.