The Flowing Liquid-Metal Retention Experiment (FLIRE) Results

R. Stubbers[1,2], M. Nieto[1,3], W. Olczak[1], D.N. Ruzic[1]

[1]*Plasma Material Interaction Group, University of Illinois, Urbana-Champaign, Illinois* druzic@uiuc.edu
[2]*NPL Associates, Champaign, Illinois,* stubbers@uiuc.edu
[3]*Argonne National Laboratory, Argonne, Illinois,* nieto@anl.gov

The flowing liquid retention experiment (FLIRE) at the University of Illinois measures the retention of implanted helium and hydrogen in a flowing liquid stream. The ability of flowing liquid metal surfaces to withstand high heat fluxes without permanent damage makes them attractive for plasma facing components (PFCs) in fusion reactor machines. An addition benefit of flowing liquid surfaces is their ability to pump gases from the divertor of a tokamak, for example. The pumping ability of flowing liquid metal surfaces is important for ash removal in the case of helium retention and low-recycling operating regimes in the case of hydrogen retention. In FLIRE, two streams of molten lithium flow down a ramp toward an exit orifice that is sealed from gas penetration by the liquid metal itself. While flowing down the ramp, an ion beam implants helium or hydrogen into the flow. After exiting this chamber, the liquid enters a separate chamber (vacuum isolated by the liquid metal) where the evolution of helium or hydrogen from the liquid is measured with a residual gas analyzer. Knowing the pumping speed implantation current and equilibrium helium/hydrogen partial pressure, the retention can be measured. FLIRE measurements of helium retention in liquid lithium show that retention varies linearly with implantation energy from 0.1% to 0.4% between 500 eV and 4keV for flow speeds of 22 cm/s over a distance of 10 cm. Based on these measurements, an effective diffusion coefficient for helium in the FLIRE lithium flow is estimated. Hydrogen retention in the flowing lithium stream is also being investigated in FLIRE. Using thermal desorption spectroscopy, the amount of hydrogen in the liquid lithium flow stream was estimated to be <0.5%, allowing an estimate of the hydrogen trapping rate.