Radiative Tin plasma clouds generated using intra-ELM energy range H^0/H^+ beams at the OLMAT High Heat Flux Facility

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Liquid metal (LM) Plasma Facing Components (PFCs) may offer advantages in terms of lifetime, power exhaust handling capabilities and crucially, resilience to transient events (such as disruptions) that may provoke a critical failure in the inner vessel and a subsequent machine shutdown. When exposed to fusion-relevant power loads LM PFCs can develop vapor clouds, being a natural response that dissipate part of the nominal power exhaust, within a process generally denominated vapor shielding [1]. The OLMAT (Optimization of Liquid Metal Advanced Targets) High Heat Flux (HHF) facility [2] employs a high-energy particle beam (mix of H^0 and H^+) with average energy around 21.7 keV (ITER intra-ELM relevant [3]) to produce power densities greater than 30 MW/m^2 in ≤150 ms pulses. In this contribution, radiative tin-enriched plasma clouds, generated in front of a Capillary Porous System (CPS) target, (W felt substrate filled with liquid tin), are investigated. The observed tin vapor-plasma clouds enabled the partial mitigation of incoming heat fluxes via radiation processes involving tin neutrals and ions (Sn^+, Sn^{2+}). The time evolution of these tin-enriched plasmas, as well as the temperature response of the target, was characterized by target embedded single Langmuir probe, visible spectroscopy, fast-frame camera imaging and pyrometry. Complex probe interpretation is presented considering multi-species, multi-charged plasma effects. Different spectroscopy measures were also utilized such as monochromatic filters for (Sn I, Sn II) and focused/defocused VUV optical fiber trying to infer possible spatial and composition differences in the radiative cloud depending on the primary beam characteristics (power load and proton fraction). Finally, the main tin erosion mechanisms (thermal sputtering and evaporation) and possible atomic processes involving keV-range energy particles (neutrals, protons) are also considered as an approximation to a real LM divertor scenario operating in detached-like state within an ELM-characterized regime.

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[3] C. Guillemaut et al., Phys. Scr. T167 (2016) 014005