Heating and transport of metal droplets in dense magnetized plasmas

S. Ratynskaia[1], L. Vignitchouk[1], P. Tolias[1]

[1] *Royal Institute of Technology (KTH), Stockholm, Sweden*

Models of dust dynamics and survivability are discussed, targeting mostly tokamak environments, but also of relevance to other plasma applications where the contribution of surface processes to heat balance is important, e.g. plasma processing or cathode spots in vacuum arcs. The discussion shall focus on the role of the source terms in the charging and heating equations, particularly those related to surface physics, such as emission processes and the microphysics of electron and ion absorption. The de-coupling between heating and charging processes in the magnetized electron collection regime, as well as the insensitivity of the droplet temperature to plasma parameters in the strong vaporization regime are also elucidated.

Modelling of these processes by the dust dynamics code MIGRAINe is exemplified for ITER-relevant regimes. In particular, we will present numerical simulations of the motion and temperature evolution of beryllium droplets, produced by first-wall surface melting after ITER major disruptions and vertical displacement events mitigated during the current quench, and their conversion into solid dust.

For predictive studies of dust survival and accumulation in future reactors such as ITER and DEMO, it is crucial to recognize that the dynamics of metallic droplets and dust is largely inertial, thus initial release conditions play a pivotal role in estimating the lifetime and final in-vessel locations of particles. Two basic dust release reactor-relevant scenarios will be briefly reviewed: droplet ejection during transient melt events and re-mobilization of pre-existing dust under steady-state and transient plasma conditions.

References:

[1] S. Ratynskaia, L. Vignitchouk, P. Tolias et al, Nucl. Fusion, **53** 123002 (2013)

[2] L. Vignitchouk, S. Ratynskaia and P. Tolias, Plasma Phys. Control. Fusion, **59** 104002 (2017)

[3] L. Vignitchouk, S. Ratynskaia, P. Tolias, et al. Nucl. Fusion, **58** 076008 (2018)

[4] S. Ratynskaia, P. Tolias, M. De Angeli et al., Nucl. Mater. Energy **12** 569 (2017)

[5] L. Vignitchouk, A. Khodak, S. Ratynskaia and I. D. Kaganovich, Nucl. Mater. Energy **25** 100826 (2020)

[6] S. Ratynskaia, E. Thorén, P. Tolias et al., Nucl. Fusion **60** 104001 (2020)