High heat loads producing dust particles in the Alcator C-Mod tokamak

C. Arnas[a], J. Irby[b], G. De Temmerman[c], C. Martin[a], C. Pardanaud[a], I. Faust[b], Y. Lin[b], S. Pierson[b], A. Autricque[d], C. Grisolia[d]

[a]*CNRS, Aix-Marseille université, laboratoire PIIM, 13397 Marseille, France*

[b]*M.I.T. Plasma Science and Fusion Center, 175 Albany Street, Cambridge, MA02139,USA*

[c]*ITER Organization, Route de Vinon-sur-Verdon, 13067 St Paul Lez Durance, France*

[d]*IRFM/CEA Cadarache, 13108 St Paul Lez Durance, France*

Plasma facing units in the ITER divertor will be formed with chains of tungsten monoblocks (MB). One identified key issue with this configuration is linked to the MB misalignment [1]. Under cycles of heat loads and transient high heat loads, the MB leading edges could be melted and induce molten material droplet emission [2]. Resulting surface damage could compromise plasma operation by changing the mechanical structure of MBs and reducing their lifetime.

One effect of the tile misalignment was evidenced in the full-metal tokamak, Alcator C-Mod. During plasma operation, camera videos have shown an over-light emission of various leading edges of plasma facing components. These regions likely already melted during plasma operation were destabilized during disruptions and led to an emission of droplets across the vacuum chamber. Resulting typically rounded dust particles (splashes and spheres) were collected. Another characteristic is their large average size (50μm) compared to the size of dust produced in other tokamaks [3]. To reduce the emission of molten material droplets, a slight rotation (~1° tilt) of all the modules of the low outer divertor was done in 2015 in order to shadow their leading edges. The dust weight after the 2015 plasma campaign was from 3 to 6 times lower than the dust weight coming from the same modules in 2007. These results, added to the fact that the average energy injected in 2280 discharges in 2015 was 0.66 MJ/discharge against 2026 discharges in 2007 with 0.45MJ/discharge shows that less dust was produced in 2015.

[1] R.A. Pitts, et al., Nucl. Mater. Energy 12, 60 (2017)

[2] B. Bazylev, et al., Phys. Scr. T138, 014061 (2009)

[3] C. Arnas, et al., Nucl. Mater. Energy 11, 12 (2017)