Contribution ID: **77** Type: **Contributed Oral**

Characterization of transient heat flux induced damages of tungsten PFCs during plasma disruption in EAST

Thursday 5 September 2024 15:55 (25 minutes)

Extreme high transient heat flux up to thousands of MW/m2 in a short pulse (~ms) during disruption in future large scale tokamak imposes great challenge on plasma facing components (PFCs), which is very concerned and worried by the ITER. Currently, understanding the consequence of thermal damage behaviors on W PFC by is an critical issue. EAST, as a superconducting tokamak, is installed metal PFCs, i.e., W PFCs for divertor and limiter, and TZM tiles for first wall, which have the similar castellated structure with ITER. After recent plasma campaigns, various damages in form of cracking and melting were post mortem inspected on divertor dome and baffle plates, first wall and limiter, which are finally distinguished to be induced by transient heat flux. Such phenomena were successfully caught by real time monitored CCD and IR cameras in plasma start-up phase of each plasma campaign, and thus these damages were generally attributed to the runaway electron(~10MeV) loss during plasma disruption. And, the circular configuration plasma tended to hit the PFCs closest to plasma if disruption occurred. For the castellated PFC structures, the melting and cracking damages often occur at the leading edges with obvious misalignment (on divertor and first wall) or the protruded parts (on limiters). In view point of melting, there were always three layers of grain from the surface to the deep region, namely columnar grain, equiaxed grain (recrystallization region) and original grain in the melting regain. The depth of columnar grain is normally 100-300μm and the depth of recrystallization region is about the same magnitude. Such grain distribution indicates steep temperature distribution from surface to the deep region when melting evens occurred. All the melting PFCs'surface morphology was similar, undulated with melting waves. The slight migration of melting layer can be observed along the toroidal direction with the in-situ melting PFCs shown here. The direction of plasma pressure and Marangoni flow was along the toroidal direction, which means they might be the dominant forces here. And, the influence of J×B force might not be obvious since the limited melting pool life which would result in the limited acceleration time and expected bulk melt displacements even J×B force was the dominant force. Meanwhile, both macrocracks and microcracks are observed on melting region on tungsten surface in some times. Moreover, macrocracks can be even observed in the region which is far away from the melting zone. There are some columnar grain even exfoliated from the material indicating severe cracking. In addition, on the leading edges without melting, visible dense cracks can be also found. Such transient heat flux induced melting and cracking by runaway electron loss during disruption in EAST provide important reference for ITER.

Speaker's title

Mr

Speaker's email address

dhzhu@ipp.ac.cn

Speaker's Affiliation

Institute of Plasma Physics, Chinese Academy of Sciences

Member State or IGO

China, People's Republic

Primary author: Mr ZHU, Dahuan (Institute of Plasma Physics, Chinese Academy of Sciences)

Co-authors: Dr WANG, Baoguo (Chinese Academy of Sciences); Dr GAO, Binfu (Institute of Plasma Physics, Chinese Academy of Sciences); Dr XUAN, Chuannan (Institute of Plasma Physics, Chinese Academy of Sciences); Mr CHEN, Junling (Institute of Plasma Physics, Chinese Academy of Sciences); Dr DING, Rui (Chinese Academy of Sciences); Dr WANG, Yang (Institute of Plasma Physics, Chinese Academy of Sciences); Dr GUO, Zongxiao (Chinese Academy of Sciences)

Presenter: Mr ZHU, Dahuan (Institute of Plasma Physics, Chinese Academy of Sciences)

Session Classification: Consequences

Track Classification: Consequences