Contribution ID: **91** Type: **Poster**

An approach to the study of crack initiation at the divertor tungsten target plates of ASDEX Upgrade

Monday, 5 June 2017 13:40 (2 hours)

The solid tungsten divertor tiles at ASDEX Upgrade experimental device have been gradually installed as substitution for W coated graphite tiles in 2012.
ASDEX Upgrade is equipped with an adiabatically loaded divertor as a compromise between available heating power, plasma discharge length and heat removal capability of divertor tiles. Accordingly, the design of the new solid tungsten plates has been conditioned by in-vessel surrounding and supporting structure. The full-scale prototypes, dimension of 250x80x15 mm^3, have been intensively tested in the high heat flux test facility GLADIS (Garching Large Divertor Sample Test Facility) [1]. The GLADIS heat loading profiles are Gaussian with central heat flux of 10 - 30 MW/m^2, resulting in an integrated absorbed power of the W tile between 100 and 280 kW. Thus simulating the expected highest power and energy loads in ASDEX Upgrade. The corresponding measured surface temperatures reached values between 1500 ℃ and 3300 ℃. In addition, cyclic loading tests have been performed with 200 cycles at 10.5 MW/m^2, 3.5 s duration. These applied loads correspond to the expected thermal loading of about 4 years of ASDEX Upgrade operation with approximately 50 high power discharges per campaign.
During the cyclic loading in the GLADIS facility, no crack initiation at the tungsten tiles has been detected. However, after one campaign of AUG operation (about 1200 plasma shots) almost all tungsten divertor tiles exhibit cracks. The inspection of the plasma exposed tiles has revealed 126 tiles with deep cracks. Nearly all of 128 tiles have shown shallow cracks in the high heat load region. Nevertheless, none of these divertor tile damages have caused an operational interruption of ASDEX Upgrade. A comprehensive investigation of the damages has been performed to find out the origin of the crack initiations [2].
This paper is presenting a bundle of numerical simulations of the ASDEX Upgrade solid tungsten divertor tiles on the basis of the theoretical hypothesis for failure of brittle materials. Accordingly, thermomechanical analyses with cyclic loading, simulating both the GLADIS and ASDEX Upgrade load profile have been performed. Additionally an assessment of the crack initiation induced by material fatigue under thermal cyclic load has been studied. Finally, the design optimisation considerations of divertor tiles are discussed.

[1] JAKSIC, N., et al., “FEM investigation and thermo-mechanic tests of the new solid tungsten divertor tile for ASDEX Upgrade”, Fusion Engineering and Design 88 (2013) 1789–1792, http://dx.doi.org/10.1016/j.fusengdes.2013.04.048.

[2] HERRMANN, A., et al., “Experiences with a solid tungsten divertor in ASDEX Upgrade”, Journal of Nuclear Materials and Energy (2016)

Eligible for student paper award?

No

Author: Mr JAKSIC, Nikola (Max Planck Institute for Plasma Physics, EURATOM Association)

Co-authors: Dr LI, Muyuan (Max Planck Institute for Plasma Physics, EURATOM Association); Mrs ZAMMUTO, Irene (Max Planck Institute for Plasma Physics, EURATOM Association); Dr HERRMANN, Albrecht (Max Planck Institute for Plasma Physics, EURATOM Association); Mr GREUNER, Henri (Max Planck Institute for Plasma Physics, EURATOM Association); Dr YOU, Jeong-Ha (Max Planck Institute for Plasma Physics, EURATOM Association); Prof. NEU, Rudolf (Max Planck Institute for Plasma Physics, EURATOM Association)

Presenter: Mr JAKSIC, Nikola (Max Planck Institute for Plasma Physics, EURATOM Association)

Session Classification: M.POS: Poster Session M

Track Classification: Plasma facing components