HIGH HEAT FLUX TESTING WITH IMPROVED DIAGNOSTICS

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Beryllium is one of the most interesting materials to be used for nuclear fusion devices. Due to its promising material properties, e.g. the good plasma compatibility, relatively high thermal conductivity, its high affinity to oxygen as well as the low activation potential, it is foreseen as plasma facing material. However, testing of beryllium components is quite challenging because of its toxicity and the required safety procedures.

This paper contains an overview of the high heat flux thermal fatigue tests carried out at Forschungszentrum Juelich (FZJ) on actively cooled beryllium mock-ups. The investigated components consist of beryllium tiles bonded to a water cooled CuCrZr body. They were tested under transient loading conditions in the electron beam facility JUDITH II.

The performance of the mock-ups was documented by temperature measurements as well as optical inspections before and after testing. Special attention was paid to the temperature measurements during the tests by using pyrometers, thermocouples and an infrared camera in order to detect local overheating of the beryllium tiles, which are a sign of bonding failures.

However, only the infrared camera is able to perform an online scan of the temperature distribution on the complete surface of the mock-up. In this particular case of temperature measurements on beryllium surfaces, it has to be pointed out that absolute temperature values measured by thermographic methods are strongly influenced by the emissivity of beryllium which changes in dependence on surface conditions and temperature. Therefore a lot of effort was put in the temperature measurement as well as in pre-investigations on thermally isolated Beryllium samples in order to get accurate surface temperatures.

Moreover, temperature information is exceptionally important to meet the requested safety standards because of the toxicity of beryllium. In order to avoid evaporation of beryllium and with respect to the fact that the vapour pressure increases with temperature, a temperature limit was set to 600°C. Based on this temperature criterion an automatic safety shut down of the electron beam facility JUDITH II was installed and tested using thermocamera measurements.

Finally examples of the temperature distribution under different loading conditions for the beryllium mock-ups are given within this paper.