RADIATION STABILITY OF RESISTIVE BOLOMETERS INTENDED FOR OPERATION IN THE ITER ENVIRONMENT

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In ITER, bolometric systems will be used to get information on the spatial distribution of the radiated power from the main plasma and in the divertor region. Initially, it was supposed to use JET-type high-temperature bolometers, which employ a thin mica substrate as the support for a delicate gold meander electrical resistance bridge network. However, an in-reactor experiment performed at the Japan Materials Testing Reactor (JMTR) in Oarai, Japan, revealed that such bolometers may not sustain the expected dose of neutron radiation of 0.02 dpa due to the both mica instability and the transmutation of gold into mercury [1].

To solve these problems it was proposed to replace mica with oxide ceramics, which were expected to be stable under radiation and have an added advantage of considerably increasing the upper temperature limit for continuous use above the 500 °C recommended for mica, and to avoid the transmutation problem, to replace gold with platinum [2].

The present report describes the in-reactor test of such a modified radiation-hard high-temperature version of the JET-type bolometer. The bolometer foil was made out of a Si wafer by etching the Si in the area dedicated for measurement and reference detector until only a thin SiN foil remains. On one side of this foil the Pt meander is sputtered and on the other the Pt absorber is deposited.

A dedicated vacuum capsule was designed and fabricated in order to allow irradiation at ~400°C in vacuum. The desired temperature was obtained by balancing the energy income due to gamma-heating and the energy loss via radiation and conductive heat transfer. The resistance of 4 Pt resistances, which form the bolometer bridge, was measured in situ. The measurements showed that the prototype bolometer remained operational during the whole irradiation cycle with the total accumulated fast neutron fluence of ~0.02 dpa [E>0.1MeV].

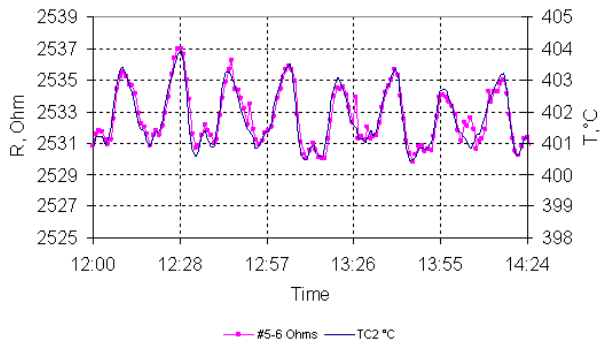

Fig.1 Variations of one of the bolometer bridge resistance in comparison with the temperature measured with a back-up thermocouple (TC2). The observed temperature variations are related with the reactor operation. The resistance changes closely follow the temperature.

The bolometer failed during unloading, when the reactor was already stopped. Visual post-irradiation examination (PIE) performed in a hot-cell allows to suppose that mechanical instability of the thin part of the bolometer foil with the Pt meander was the reason of the observed problem. We conclude that the proposed approach allows designing ITER-compatible rad-hard bolometers. The increase in stability is a subject of current investigation

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