ITER IN-VESSEL MAGNETIC SENSORS PROTOTYPING AND TESTS

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The ITER in-vessel equilibrium magnetic sensors will be installed in a hostile environment having strong neutron irradiation and cyclic heat loads which cause undesired effects that can compromise the accuracy of the measurements.

The Low Temperature Co-fired Ceramics (LTCC) technology has been chosen as a potential candidate for the manufacture of magnetic sensors for ITER. LTCC sensors are compact circuits formed by ceramic layers with printed metallic tracks, high-pressure laminated and fired at a relatively low firing temperature (850 °C) to obtain a single object compatible with high electrical and thermal conductivity metals (Ag, Au). With respect to standard pick-up coils made of Mineral Insulated Cables, the LTCC sensors should allow to improve the radiation hardness and increase the Signal/Noise ratio by reducing the spurious signals induced by thermal gradients inside the sensors (TIEMF effect [1]).

A new set of pick-up coils made with the LTCC technology has been recently developed and constructed by means of an industrial collaboration, on the basis of previous experience gained with the realization of a first set of LTCC sensor prototypes [2]. The new set of prototypes was aimed at obtaining a sensor with an increased magnetic area from $0.08 m^2$ to $0.32\ m^2$, compatible with ITER requirements, and at testing different compositions for the ceramic layers and conductor material (Au with respect to Ag).

The sensors have been subjected to various tests including: mechanical, electrical, magnetic and thermal characterization, micrographic analysis and vacuum out-gassing in ITER relevant conditions. In addition, specific tests have been designed for the measurement of the TIEMF effect.

The paper will present the development of the sensors and the results of the tests and will discuss the irradiation tests to be carried out on the LTCC sensors to verify their compliance with ITER requirements.

[1] G. Vayakis, et al., Radiation-induced thermoelectric sensitivity (RITES) in ITER prototype magnetic sensors, Rev. Sci. Instrum. 75 (10) (2005) 4324-4327.
[2] G. Chitarin, et al., "Technology developments for ITER in-vessel equilibrium magnetic sensors", Fusion Engineering and Design 84 (2009) 593-598.

Topic D: Diagnostics, Data Acquisition and Remote Participation.