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## Prototype manufacturing and testing of metalized ceramic printed circuit boards for ITER Bolometer cameras

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The ITER bolometer diagnostic will be based on 110 five-channel metal resistive sensors distributed all around the vessel [1]. In order for the diagnostic to meet its operational and programmatic goals, a mechanically stable and reliable electric connection is required. Spring loaded connection of the sensor or crimped wires to connect the external cables, as used in current day fusion experiments, are not suitable to operate under ITER's challenging nuclear and thermal loads. In addition, the design must not exceed its space envelope and an efficient way how to customize the sensor position according to the final blanket module positions has to be demonstrated. Excellent thermal conductivity in these internal components is also a requirement in order not to overheat the sensor.

In this paper, a design solution based on metalized ceramic aluminum nitride substrates providing the electrical interface between the internal bolometer sensor and the externally connecting macroscopic MI cables, is proposed. The substrates, also referred to as printed circuit boards (PCB), can be manufactured having a complex 3-D shape and can be coated on multiple sides with micrometer thick conductive tracks and pads.

It is shown, that the sensor can be supported mechanically with an integrated design small enough to fit into the tight space envelope reserved for the ITER bolometer cameras. A solution, to allow flexibility in sensor positioning during assembly, will be explained. Investigations into bonding and micro welding techniques to provide a reliable electrical connection as well as the possibility to integrate a remote-handling compatible connection will be discussed.

Prototypes based on a simplified PCB design have been manufactured by micro-dispensing, laser etching and laser activation in order to validate these technologies for the demanding ITER environment. To determine the exact specifications and design constraints for the final electrical interface, these simplified PCBs contain vias, bond pads coated with different material combinations (Au, Pt, Cu) and tracks running over 3-D shaped surfaces.

Test results on mechanical stability and electrical properties of the different simplified PCBs before and after thermal cycling are discussed together with the analysis of the achieved electrical track widths and thicknesses and their impact on the diagnostic performance. Moreover, conclusions and considerations on cost-effective manufacturing will be presented. The paper concludes with an outlook describing the preliminary bonding specifications and challenges for the internal bolometer sensor and the external MI cables.

References:

[1] H. Meister et al.: Current status of the design of the ITER bolometer diagnostic, submitted to Fusion Engineering & Design, 2016.

### Eligible for student paper award?

No

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