REALIZATION OF A FIRST SERIES OF COPPER PROTOTYPES FOR THE SPIDER GRIDS

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The active cooling of the Ion source grids for SPIDER and MITICA experiments presents critical issues that require specific R&D to investigate heat transfer and technological aspects in electrodeposited cooling channels. The grids must be manufactured by electrodeposition of pure copper onto a copper base plate to realize the grids cooling channels and magnets slots. This process permits to obtain very complex geometric shapes and to have good mechanical properties, due to the copper high purity and very small grain size of electrodeposited Cu. Friction welding, giving a reliable and leakage free connection between components of different materials, is proposed for the joints between copper grid and stainless steel manifolds. The application of these techniques to the grid geometries, where the water distribution pipes are welded in the grids thickness having the same size of pipe diameter, present some technological issues and needs of customization. Suitable manufacturing parameters and production methodologies require being identified by prototypes construction and testing. Therefore, proper research activities have been carried out and a series of prototypes of single channels grids have been realized at Consorzio RFX.
In particular, a plate has been designed containing nine prototypes: three prototypes represent the Plasma Grid cooling channel, three the Grounded Grid and the remaining the Extraction Grid, which is the only one featuring a double channel. The prototypes (200x30x10 mm) have been arranged forming a grid-like configuration, designed in order to test the feasibility of the electrodeposition manufacturing and the lateral side welding of the tubes on geometries similar to the SPIDER grids. On the extraction grid prototypes, a series of thermocouples have been embedded very close to the cooling channel wall, by using a electrodeposition process specially developed to this purpose. Good results have been obtained using these techniques. An accurate map of the prototypes wall temperatures allows to evaluate local heat transfer coefficients and to identify local spots where dry-out phenomena might occur. In order to carry out heat transfer and pressure drop investigations on grid cooling channels, the prototypes will be employed in the test bed ICE [1]. ICE has been conceived to reproduce the SPIDER/MITICA conditions to observe the thermo-hydraulic behavior of grid cooling channels.

[1] F. Fantini et al., “An experimental test bed for thermo-electrical and thermo-fluid dynamics investigations”, Proceedings of the 9th International Symposium on Fusion Nuclear Technology, October 11-16 2009, Dalian, China