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TOPIC: F - Plasma Facing Components

Fast brazing development for the joining of the beryllium armor layer for the ITER First Wall panels (P2-F-38)

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In order to reduce cost and manufacturing time induction brazing is being developed as an alternative to Hot Isostatic Pressing for the joining of the beryllium armor onto the copper alloy heat sink material for the manufacture of First Wall panels for the ITER Blanket. The copper alloy that is currently adopted by ITER is a Copper Chromium Zirconium alloy. Its good mechanical properties are obtained by precipitation hardening by means of an ageing heat treatment at a temperature of about 480 °C. In order to avoid over-ageing and keep acceptable mechanical properties, brazing at higher temperatures must therefore be done as fast as possible.
The flat geometry of a panel is not familiar for induction process; nevertheless, a development work was done validating the feasibility of joining beryllium tiles onto a copper chromium zirconium flat surface of a panel by induction brazing process.
The development was done in 2 stages: validation of the capability of the induction process to realise a heat cycle on a dummy panel and in parallel, validation of the brazing parameters giving acceptable mechanical results on the beryllium CuCrZr joint.
A flat pancake inductor was manufactured and tested on a dummy panel in an induction brazing vessel manufactured for this purpose. Several heating cycles were done with the aim of defining a cycle that gives uniform temperature at the interface of all the beryllium tiles on the entire panel surface. These cycles gave us a temperature range in which the brazing can be performed. A special device for brazing small mock up was also manufactured. This was for the metallurgical characterisation program.
Many brazing samples where done and mechanically characterised. Unfortunately, this first metallurgical stage led to unacceptably low shear test values. A complete analysis of this non conformance put in evidence that the bad results were due to the braze material that was not adapted to this process. By changing the braze material chemical composition, the mechanical characteristics where much improved and allowed us to manufacture a mock up for high heat flux test.