Non-destructive testing of CFC/Cu joints (P2-F-468)

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Reliable non-destructive tests (NDT) are fundamental for the manufacturing of ITER components, especially for high heat flux plasma facing components.

NDT include various techniques, which allow inspection of a component without impairing serviceability; it's important to detect and characterize defects (type, size and position) as well as the set-up of acceptance standards in order to predict their influence on the component performance in service conditions. The present study shows a description of NDT used to assess the manufacturing quality of CFC (carbon fibre reinforced carbon matrix composites)/Cu/CuCrZr joints. In the ITER divertor, armor tiles made of CFC are joined to the cooling structure made of precipitation hardened copper alloy CuCrZr; a soft pure Cu interlayer is required between the heat sink and the armour in order to mitigate the stresses at the joint interface. NDT on CFC/Cu joint are difficult because of the different behavior of CFC and copper with regard to physical excitations (e.g. ultrasonic wave) used to test the component; furthermore the response to this input must be accurately studied to identify the detachment of CFC tiles from Cu alloy.

The inspected CFC/Cu/CuCrZr joints were obtained through direct casting of pure Cu on modified CFC surface and subsequently through brazing of CFC/Cu joints to CuCrZr by a Cu-based alloy. Different non-destructive methods were used for inspecting these joints: lock-in thermography, ultrasonic inspections, microtomography and microradiography.

The NDT tests were followed by metallographic investigation on the samples, since the reliability of a certain non destructive test can be only validated by morphological evidence of the detected defects. This study will undertake a direct comparison of NDT used on CFC/Cu joints in terms of real flaws presence. The purpose of this work is to detect defects at the joining interface as well as in the cast copper (for instance voids).

The experimental work was developed using different NDT on the same sample and comparing the response of the analysis.

The ultrasonic inspection gave results in contrast with morphological observation.

X-ray tomography can offer only a qualitative information on CFC/Cu interface, since carbon is significantly less X-rays sensitive than copper, while lock-in thermography offers information on thermal continuity at interface.