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Extensive Characterisation of Copper-clad plates, Bonded by the Explosive Technique, for ITER Electrical Joints.

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Cable-in-conduit conductors will be extensively implemented in the large superconducting magnet coils foreseen to confine the plasma in the ITER experiment. The design of the various magnet systems imposes the use of electrical joints to connect unit lengths of superconducting coils, by inter-pancake coupling.

The design is based on a twin-box lap type joint. By fabrication of twin terminals at both conductor ends, soldered together, the concept allows for the joints to be dismountable. Each terminal is manufactured by compacting the stripped cable end into a bimetallic box, machined from a copper-clad plate, bonded by the explosive technique.

Various characteristics, amongst which electrical resistance and mechanical strength, have to be addressed to obtain satisfactory joint operation while avoiding degradation of conductor performance. The joints are submitted to fast varying magnetic fields, inducing locally high stresses, requiring for the bimetallic material to exhibit sufficient mechanical strength at 4.2 K.

As a result of operating conditions involving transient magnetic fields during coil operation in certain magnet systems, eddy currents are induced in the copper sole, leading to Joule-heating, hence a reduced superconductor stability. The use of a low purity copper cladding, featuring a low residual resistivity ratio (RRR) will be efficient to increase loop resistance and reduce induced currents. However, the joint must also comply with a low DC resistance requirement to prevent excessive energy loss.

To validate technical joint solutions for the various magnet systems, non-destructive, micro-optical and mechanical examinations were conducted to assess the performance of numerous copper-clad plates. These tests confirmed the suitability of such copper-clad plates for an overall joint application. Additionally a discussion is presented concerning the compatibility of certain copper purity grades, aiming at identifying the most suitable copper grades for the different joints types.

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