Recent developments in Europe on bonding technologies for high heat flux components


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The development of fusion as a potential energy source has led to the development of larger machines capable of longer pulse operation. Longer pulse operation, given the high heat loads present in fusion machines, requires active cooling and can no longer rely on the inertial cooling of the plasma facing materials. The consequence of this is that the materials currently selected as plasma facing materials need to be attached, both thermally and mechanically to heat sinks where the heat can be removed. At present there are three materials, beryllium, carbon, as carbon-carbon fibre composite and tungsten that are proposed for first wall applications. Each material has advantages and disadvantages for this crucial role facing the plasma and the debate as to which material best suits these requirements has been a major issue for fusion in the last decade.

Some of the major requirements for the selection of the first wall material for these applications are the ease with which they can be joined to heat sink materials, the reliability of the joined materials under conditions present in fusion devices, the qualification of the joining techniques and the qualification of the actual components that are produced.

The paper will summarise and review the recent work performed in Europe aimed at producing first wall components for fusion devices which have the plasma facing materials attached to heat sinks in a manner that will survive the relevant conditions, taking into account the constraints imposed by the industrial processes used. In performing this review the different grades of material used, the different joining techniques being developed and qualified, the qualification methods used for the small scale and actual size components will be addressed.

Given that machines can have 10⁶ or more individual tiles joined to heat sinks, the paper will also review the methods used to minimize joint defects in installed components and the efforts made to make designs tolerant to individual tile failure.

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