LASER-ASSISTED JOINING OF SIC/SIC COMPOSITES USING SAY (SILICA ALUMINA YTTRIA) FOR HIGH-PERFORMANCE NUCLEAR APPLICATIONS

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The exceptional mechanical, thermal and radiation resistant properties of SiC/SiC composite materials make them a top contender for high temperature applications in various fields, among which, their application to nuclear reactors in reactor breeding blanket, structural components, etc, is currently widely being explored by researchers around the globe. However, joints between these composite parts are inevitable due to the intricacies of the structure. Since Silicon Carbide composites cannot melt, joining them using welding is difficult. Thus, the role of filler materials like glass ceramics comes into play. Nevertheless, it is important to choose a filler material which has a coefficient of thermal expansion quite close to SiC/SiC composite, has a good wettability with the composite material and has good thermo-mechanical properties at high temperatures. Using SAY (Silica Alumina Yttria) as filler material is an ideal choice due to its great compatibility with SiC/SiC and due to good thermal resistance. However, another important factor to be considered is making the joining process pressure-less and localized to the area to be joined to avoid any thermal stresses in the adherends. The present research work, therefore, explores the usage of SAY as joining material for Silicon Carbide fibres embedded in Silicon Carbide matrix for a pressure-less, localized heated joining using infrared diode laser. Key controlling parameters for obtaining optimum, strong joints are laser power, exposure time, laser focus, laser position, specimen position during treatment, SAY slurry application methods and slurry consistency. Together with continuous optimization of these parameters, the joint strength is quantified through mechanical tests using a universal tensile testing machine while using a set-up specially designed for these kinds of joints. Additionally, computed tomography and scanning electron microscopy are used to understand the behaviour of the filler material before and after mechanical testing. It is found that using laser for joining of SiC/SiC using SAY as a filler material can resist a force as high as 2100N. Lastly, a comparison is made between using SAY as filler material compared to SAY containing Silicon Carbide particles while keeping the laser parameters constant.

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