SOLID STATE BONDING OF CUCRZR TO 316L STAINLESS STEEL FOR ITER APPLICATIONS

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The ITER First Wall consists of a beryllium-tiled, copper alloy heat sink bonded to a stainless steel support structure. Developments in the design of the First Wall require that in high heat flux regions, the CuCrZr-316L joint be wet, that is form the pressure boundary for the cooling water. As such, renewed attention is being given to the microstructural characteristics and mechanical robustness of this interface.

Prior work has focused mostly on the structure and properties of hot isostatically pressed (HIP) CuCrZr/316L SS joints. In such bonds, strength is derived from interdiffusion across the material interface. Changes in composition, structure and grain size resulting from such interdiffusion and the necessary elevated temperatures can compromise the mechanical integrity of the joint especially after the Be tiles are diffusion bonded to the copper in a subsequent joining step.

Recent work has examined the efficacy of explosion bonding as a way to reduce or eliminate these shortcomings. Explosion bonding is essentially an athermal process and as such there is no long range interdiffusion as is the case for HIP. In addition, the cold work induced in the copper alloy during the explosion bonding process is sufficiently high as to result in a considerably stronger CuCrZr/316L structure. More importantly, this cold work permits the Be tiles to be bonded to the copper alloy at a substantially higher temperature while maintaining strength (see Figure 1), rendering that critical bond more reliable.

We will compare the microstructure and mechanical performance of CuCrZr/316L stainless steel joints prepared via both techniques. Analysis of the joints includes mechanical measurements of bond strength and microstructural characterization using optical and electron microscopy techniques. Particular emphasis is placed on the as-bonded and residual mechanical properties of the CuCrZr, since it undergoes additional thermal processing during Be bonding and cannot be solutionized and age-hardened using traditional techniques.

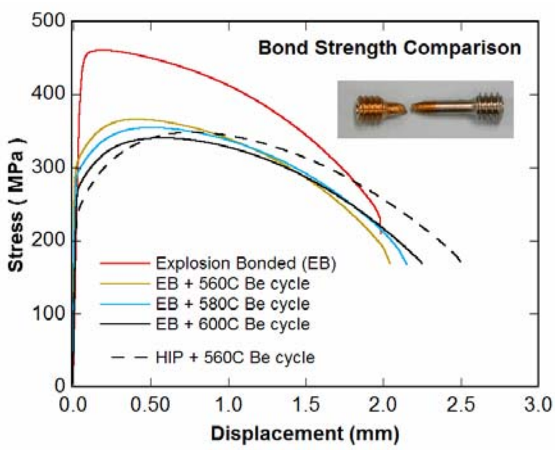

Figure 1. Comparison of residual strength of explosively bonded CuCrZr/316L SS after Be tile bonding cycles to that of a HIP processed bond.

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