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MECHANISMS OF BOND FORMATION IN HYBRID FRICTION DIFFUSION BONDING PROCESS FOR TUBE TO TUBE-SHEET JOINTS

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In the novel solid state joining process Hybrid Friction Diffusion Bonding (HFDB), a rotating tool is employed to apply axial force onto the joining partners, and bonding is achieved by frictional heating, plastic deformation and diffusion. In this study, a variant of the process was utilized to join tubes and tube sheets made from two 5XXX series aluminum alloys. The bonding mechanisms were investigated using optical microscopy, temperature measurements, energy dispersive x-ray spectroscopy and finite element analysis. The thermo-mechanically affected zone with small, equiaxed grains was found to be located in the contact area between tool and workpiece. A heat affected zone is visible by microscopy due to differences in grain structure, but the thermal model reveals temperatures suitable to initiate microstructural changes to larger depths. A diffusion distance of Mg of 12 µm was measured allowing for the formation of sound bonds within short welding times.