

Friction Stir Welding of Stainless Steel and Nickel Base Alloys

Russell J. Steel, MegaStir Technologies

Tracy W. Nelson, Carl D. Sorensen, Brigham Young University

Scott M. Packer, Advanced Metal Products Inc

Introduction

Traditionally, arc welding processes are used in joining stainless steels and nickel base alloys. Arc welding processes generally produce very high peak temperatures in the weld and heat affected zone (HAZ), which is detrimental to the quality as well as the mechanical and physical properties of the weld and HAZ.

Friction Stir Welding (FSW) unlike arc welding is a solid-state process that is able to join materials below the actual melting temperature. A new tool material consisting of Polycrystalline Cubic Boron Nitride (PCBN) has demonstrated feasibility in FSW of stainless steels and nickel alloys. This paper will present the mechanical properties, microstructures, and welding parameters of various friction stir welded stainless steel and nickel base alloys.

Procedure

FSW tools made of PCBN were used to produce butt welds in various stainless steel (304L and 316L) and nickel base alloys (alloy 600). Mechanical properties were determined using transverse tensile testing, while the evaluation of weld microstructure was determined through metallographic examination, microhardness testing, and Orientation Imaging Microscopy (OIM). The tool life was evaluated through visual inspection and critical tool dimensions.

Results and Discussion

FSW weldments produced with PCBN showed excellent mechanical properties with little or no distortion. Materials such as 316L stainless steel achieved 95% joint efficiency in transverse tensile tests at travel speeds up to 15 ipm in 0.125" thick base metal. In the stainless steel and nickel base alloys, significant grain refinement was observed in the weld region resulting in a fine

equiaxed grain structure. Welding parameters were shown to be crucial in obtaining good weld quality, properties and maximum tool life.

Conclusion

Results of study illustrated feasibility and excellent weld mechanical properties obtained in stainless steel and nickel base alloys via FSW. Mechanical properties and welding parameters will be presented, along with parameters pertaining to tool life.