SPC5. Friction-Stir Welding Al-6xn

Suzanna M. Klingensmith and Masashi Watanabe, Lehigh University

Introduction

Friction-stir welding (FSW), a relatively new joining process, has several advantages to fusion welding. For example, fusion welded super-austenitic stainless steels (SASS) experience microsegregation – leaving the weld zone highly susceptible to corrosion. Because FSW is a solid-state process, microsegregation should be avoided and corrosion resistance should be superior to that of fusion welds. Although, aluminum FS welds have been extensively characterized in the literature, there is little information of FS welded SASS. In this poster, the microstructure of FS welded AL-6XN plates has been thoroughly investigated and characterized.

Technical Approach & Results

The microstructure of AL-6XN plates joined via a double-sided friction stir weld has been investigated using LOM, SEM, and TEM techniques. The three microstructural zones that develop during FSW reflect decreasing strains and less severe thermal cycles with increasing distance from the weld centerline. The nugget, located around the centerline, has a refined structure of equiaxed grains as a result of the extreme strain and temperatures during welding. Several features are seen within the nugget, one of the most prominent being a steady stream of tungsten inclusions created by accelerated tool wear. The heat affected zone consists of large austenite grains and small nucleated grains at grain boundaries. The thermal mechanical affected zone, located between the nugget and heat affected zone, shows a microstructural transition from the completely refined structure to a structure very similar to the base metal. Of particular importance is that, unlike fusion welding, microsegregation has been avoided during FSW. Due to the changing microstructure from base metal to the weld zone, there are corresponding changes in hardness. Moving towards the centerline from the base metal, hardness increases as a result of the gradual refinement of microstructure.

Conclusions

A FS weld of AL-6XN shows a microstructural transition caused by decreasing strains and temperatures with increasing distance from the weld centerline. The nugget, at the weld centerline, has the finest structure, composed of small equaixed grains. Moving away from the centerline, passing through the TMAZ and HAZ, the microstructure becomes less and less refined until it complete unaffected by FSW, consisting of large equiaxed austenite grains. As expected, there was no evidence of microsegregation in any region of the weld. Therefore, AL-6XN FS welds should have superior resistance to AL-6XN fusion welds.