

# The Influence of Tool Geometry on Mechanical Properties of Friction Stir Welded AA-2024 and AA-2198 Joints

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## Abstract

The tool geometry in friction stir welding (FSW) is a critical parameter to produce reliable and consistent joints, especially when it comes to joining dissimilar alloys with different mechanical and thermal properties. The aim of the present work is to investigate the effect of FSW tool design on the mechanical characteristic of as-welded AA2198(T3)-AA2024(T3) joints. Three shoulder profiles (flat, spiral, and fan) and five different pin profiles (tapered cylindrical, straight cylindrical, threaded cylindrical, cone and square) were tested. A visual inspection and metallographic characterization were conducted to evaluate the sound state of the joint. Tensile tests and scanning electron microscopy combined with energy-dispersive X-ray spectroscopy were used to assess the mechanical properties of the different joints in regard to fractographic analyses and local chemical composition. Significant flash was produced for flat shoulder configurations. FSW tools with fan or with spiral shoulders prevent the formation of the flash defect. Lack of penetration (LOP) and kissing bond defects were avoided by tapering the tip of the pin with a diameter greater than or equal to the plate thickness. The tapered cylindrical pin with a fan shoulder was the optimal tool design configuration for mechanical properties.

**Keywords:** FSW tool design; friction stir welding; Al-Li alloys; 3<sup>rd</sup> generation aluminum alloys; 2024 aluminum alloy.