

Friction Stir Welding of Al 6063 & Al 7075

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ABSTRACT: This paper describes about the friction stir welding is carried on aluminum 6063 and aluminum 7075. while performing the operation , we observe various welding parameters like tool rotation speed (rpm) welding speed has been optimized so that it can be performed to all ranges of parameters. After welding the various samples is cut into small specimens a per ASTM standards. so that we can perform microhardness , vickerhardness and tensile strength. Their structure, physical, chemical and mechanical properties of the composite are discussed in connection with the influence of size effects and other features in detail to make high end materials.

KEYWORDS: Synthesis, Polytypes, Nonocomposite, Characterization

INTRODUCTION

Friction-stir welding (FSW) is a solid-state joining process (the metal is not melted) that uses a third body tool to join two faying surfaces. Heat is generated between the tool and material which leads to a very soft region near the FSW tool. It then mechanically intermixes the two pieces of metal at the place of the join, then the softened metal (due to the elevated temperature) can be joined using mechanical pressure (which is applied by the tool), much like joining clay, or dough. It is primarily used on aluminium and most often on extruded aluminium (non-heat treatable alloys), and on structures which need superior weld strength without a post weld heat treatment.

It was invented and experimentally proven at The Welding Institute UK in December 1991. TWI holds patents on the process, the first being the most descriptive. A constantly rotated non consumable cylindrical-shouldered tool with a profiled nib is transversely fed at a constant rate into a butt joint between two clamped pieces of butted material. The nib is slightly shorter than the weld depth required, with the tool shoulder riding atop the work surface.

Frictional heat is generated between the wear-resistant welding components and the work pieces. This heat, along with that generated by the mechanical mixing process and the adiabatic heat within the material, cause the stirred materials to soften without melting. As the pin is moved forward, a special profile on its leading face forces plasticized material to the rear where clamping force assists in a forged consolidation of the weld.

This process of the tool traversing along the weld line in a plasticized tubular shaft of metal results in severe solid state deformation involving dynamic re-crystallization of the base material. Friction Stir Welding can be used to join aluminium sheets and plates without filler wire or shielding gas. Material thicknesses ranging from 0.5 to 65 mm can be welded from one side at full penetration, without porosity or internal voids. In terms of materials, the focus has traditionally been on non-ferrous alloys, but recent advances have challenged this assumption, enabling FSW to be applied to a broad range of materials.

FRICION STIR WELDING PROCESS

In FSW, a cylindrical shouldered tool with a profiled pin is rotated and plunged into the joint area between two pieces of sheet or plate material. The parts have to be securely clamped to prevent the joint faces from being forced apart. Frictional heat between the wear resistant welding tool and the work pieces causes the latter to soften without reaching melting point, allowing the tool to traverse along the weld line.

The plasticized material, transferred to the trailing edge of the tool pin, is forged through intimate contact with the tool shoulder and pin profile. On cooling, a solid phase bond is created between the work pieces. In terms of high-temperature materials, FSW has been proven successful on numerous of alloys and materials, including high-strength steels, stainless steel and titanium. As what is weldable refers to the material by which the welding tool is made and how

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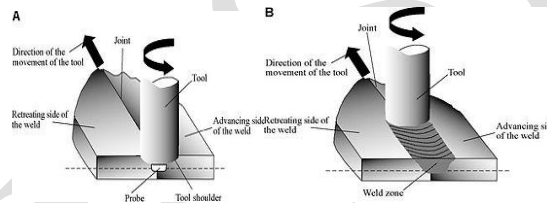
the process is applied there are really no limits to what can be achieved. An improvement on the existing methods and materials as well as new technological development, an expansion is expected.

PROCESS CHARACTERISTICS OF FSW

The FSW process involves joint formation below the base material's melting temperature. The heat generated in the joint area is typically about 80-90% of the melting temperature. With arc welding, calculating heat input is critically important when preparing welding procedure specifications (WPS) for the production process. With FSW, the traditional components – current and voltage – are not present as the heat input is purely mechanical and thereby replaced by force, friction, and rotation. Several studies have been conducted to identify the way heat is generated and transferred to the joint area. A simplified model is described in the following equation.

$$Q = \mu\omega FK.$$

Weld ability of the materials can be varied in terms of shapes, comprising steps of urging and securing the assembled members towards each other, entering the assembled members along the joining line by a probe of material harder than the material of joined members under rotating movement which generates a frictional heat, thereby creating a plasticized region in the adjacent members' material, the method further comprising a homogenization of the resulting weld seam ensured by an enhanced flow of plasticized material both perpendicularly and vertically to the longitudinal extension of the adjacent assembled members by exposing the created plasticized material to a perpendicular pressure along the surface of the members and causing simultaneous material flow along the probe pin in the vertical direction allowing the plasticized material to solidify behind the probe.



The welding of aluminium and its alloys has always represented a great challenge for researchers and technologists. Friction stir welding (FSW) is a new welding process that has produced low cost and high quality joints of aluminium alloys.

Material study of AA7075 Alloy

One of the materials has been selected as AA7075 alloy. The prime reasons for selecting this material are discussed in the following. There is high potential for research and development of further applications of this material.

The other material that has been selected is AA6063 aluminium alloy. The prime reason for selecting this material is discussed in the following. There is high potential for research and development of further applications of this material. Using AA6061 T6 alloy for friction stir welding of dissimilar materials has thus been preferred over other alloys.

Tensile Testing

The materials were subjected to initial tensile test in order to find out its mechanical properties. The following observations were made:

The initial tensile test has been carried out at a universal testing machine at Omega Inspection Laboratory, Guindy.

Sample details:

6 mm thick aluminium AA6063 sample

6 mm thick aluminium AA7075 sample

Equipment used :

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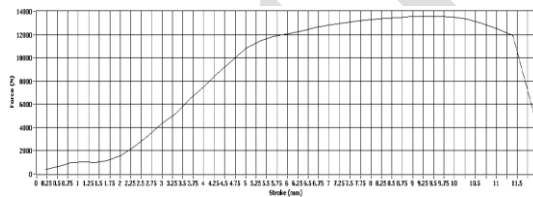
UTM Make : UTM 40. SR no. 11/98
 Manufacturer : F. I. E (Nashik Engineeing Clusters)
 Model : UTE 40

C. Testing of AA6063 Aluminium alloy:

Specifications	Minimum	Actual Values
Tensile Strength (MPa)	260	371.23
Yield Stress (MPa)	240	295.86
Elongation (%)	16	22.4

Testing data:

Sample type : flat
 Mode of test : tension
 Area : 36.54 mm²
 Gauge length: 25mm



D. Result of Tensile Stress:

Initial gauge length : 25.00 mm
 Final gauge length : 29.60 mm
 Maximum force (F_{max}) : 10.97 KN
 Ultimate Tensile Stress : 295.13 MPa
 % of Elongation : 18.40%
 Yield Stress : 255.80 MPa



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E. Process Requirement for FSW:

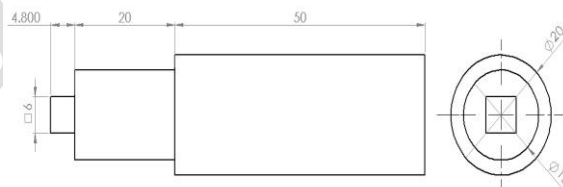
The tool typically consists of a rotating round shoulder and a pin that heats the work piece, mostly by friction, and moves the softened alloy around it to form the joint. Weld quality and tool wear are two important considerations in the selection of tool material, the properties of which may affect the weld quality by influencing heat generation and dissipation. The weld microstructure may also be affected as a result of interaction with eroded tool material.

Apart from the potentially undesirable effects on the weld microstructure, significant tool wear increases the processing cost of FSW. Owing to the severe heating of the tool during FSW, significant wear may result if the tool material has low yield strength at high temperatures. Stresses experienced by the tool are dependent on the strength of the work piece at high temperatures common under the FSW conditions. Temperatures in the work piece depend on the material properties of tool, such as thermal conductivity, for a given work piece and processing parameters.

The coefficient of thermal expansion may affect the thermal stresses in the tool. Other factors that may influence tool material selection are hardness, ductility and reactivity with the work piece material. The tool hardness is important in mitigating surface erosion due to interaction with particulate matter in the work piece.

F. Design of Tool:

The flow of plasticized material in the work piece is affected by the tool geometry as well as the linear and rotational motion of the tool. Important factors are shoulder diameter, shoulder surface angle, pin geometry including its shape and size.



IV. CONCLUSIONS

Aluminium alloys; AA6063 T6 and AA7075 T6 were welded using Friction Stir Welding (FSW) process. Two different tool profiles (Square and Taper cylindrical threaded) were used to do the welding at two different tool rotation

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speeds (800 rpm and 900rpm). Tensile tests, Microstructure tests and Macrostructure tests were done on the four specimens.

Hence, it can be concluded that the best tool profile of a HSS tool to weld AA6063-T6 and AA7075-T6 using FSW process would be square shaped. The tool rotational speed should not exceed 1000 rpm as the weld finish achieved would be unsatisfactory and that better welding is achieved at 800 rpm. The defects revealed in the micro and macrostructure suggests that the axial force of 3 kN was insufficient and that it should be increased to obtain a perfect weld.

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