Characteristic Analysis and Optimization of Aluminium and Titanium Composed Joining by Friction Stir Welding

1. Background of the Problem

There is a high demand for combination of light weight alloys in modern Technological growth. In the aerospace, automobile and shipbuilding industries there is a need of Combinations of light weight alloys In all these applications it becomes necessary to get the higher performance of the welded joints. The main advantage of using dissimilar materials in welding structure is that, we can take the advantage of the properties of both the materials. Aluminum alloys are widely used in automotive industry, aerospace industry and shipbuilding. Titanium alloys have also attracted much attention in these industries due to their high strength and high corrosion resistance. With the increasing demand for lightweight equipment, these alloys have been increasingly used. In many applications, superior properties of both aluminium alloys and titanium alloys, such as high strength, low weight and low cost are needed. Because of many differences between these two metals, such as differences in crystal lattice, melting temperature, thermal conductivity, and coefficient of linear expansion, it is very difficult to achieve a defect-free joint between these two alloys[1][2]. Friction Stir Welding (FSW) appears as one of the most promising continuous joining techniques. In which the effectiveness of the obtained joint is strongly affected by several geometrical and technological parameters; in particular both rotating speed and feed rate have to be properly chosen in order to obtain effective joints [3].In this Research the experimental characteristic analysis of Aluminium and Titanium composed joint by FSW will be done. Process parameter for FSW will be optimized for getting various material characteristics of joint.

2. Literature Review

Chan et al Experimented FSW on commercially pure titanium with ADC12 cast aluminum alloy using WC-Co tool. Three welding speeds are selected as 60, 90, 120 mm/min. Maximum failure load of 9.39 KN is achieved at 90mm/min. Defects arise at 60mm/min due to insufficient flow of Ti which cause inhomogeneous distribution. At 120 mm/min due to lower heat input and low reaction time for Ti and Al, decrease in tensile strength is observed [4]. Li et al employed the modified butt joint into the FSW of Ti-6Al-4V alloy to Al-6Mg alloy with a special pin plunge setup. The results reveal that the joint mechanical tensile strength can reach more than 92 % of the parent aluminum alloy strength [5]. Yu-hua et al observed Uneven distribution of micro hardness in Lap joint of TC1 Ti alloy and LF6 Al alloys dissimilar materials were subjected to FSW. With the increase of welding speed or decrease of tool rotation the amount of titanium alloy particles stirred into stir zone by the force of tool pin decreases continuously. [6]. Masayuki et al joined ZK60 magnesium alloy and titanium by friction stir welding. In this study the effect of alloying elements on the microstructure of the joint was examined It was found that Zn and Zr of alloying elements of Mg-Zn-Zr alloy improved the tensile strength of titanium and magnesium joints by forming the thin reaction layer at the joint interface.[7] Song and Nakata in 2010 investigated the mechanical properties and the effect of post heat

treatment in the FSW of Inconel 625. They noticed an improvement in mechanical properties after the post heat treatment at 700°C for100h in vacuum.[8]. Sato et al. studied the effect of microstructure on weldment of Inconel 600 alloy in a friction stir welding process using polycrystalline cubic boron nitride (PCBN) tool. They found fine grain structure in stir zone with better mechanical properties compared to the base metal. They also observed that FSW exhibits lower corrosion resistance in stair zone and HAZ[9]. Song and Nakata investigated the mechanical properties and the effect of post heat treatment in the FSW of Inconel 625. They noticed an improvement in mechanical properties after the post heat treatment at 700°C for100h in vacuum [10].The problem has been identified from the literature review that there is a scope of the research in the area of Aluminum and Titanium composed joining by FSW.

3. Objective of the Research

The main objective of this research is to analyse the material characters of Aluminium and Titanium composed joining by Friction stir Welding. Optimization of FSW process parameter will be done for better joint. Mathematical Model will be developed from the optimized result.

Specific Objects

1. To make join Aluminium and Titanium alloy by FSW.
2. To make different samples by optimizing parameters
3. To conduct different Testing Methods
4. To Analyze the Joined material Properties
5. To adapt the optimization Techniques for finding the solution
6. To Formulate the Mathematical Model

4. Methodology

1. Literature Review
2. Observation and Data Collection
3. Making samples by varying process Parameters
4. Conducting Test for samples, The following test will be conducted for the samples
    - 4.1. Tensile Test
    - 4.2. Scanning Electron Microscope Test (SEM)
    - 4.3. Impact Test
    - 4.4. Micro Hardness Test
    - 4.5. Micro Structure Analysis for each Test
5. Optimizing the Parameters by optimization Technique
6. Generating the Mathematical Model
7. Journal Publication
8. Preparing Thesis

5. Work Plan Activity

The Planning schedule for each Research activities have been mentioned below

S.N	Activity	Duration (Month)	Month																	
			2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
1	Literature review	6																		
2	Observation & Data collection	6																		
3	Making samples	2																		
4	Conducting Test and Experiments	4																		
5	Optimizing Parameters	2																		
6	Generating Mathematical Model	10																		
7	Journal Publication	4																		
8	Preparing Thesis	2																		

6. References

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