

# Evaluation of Mechanical Behavior of Gas Tungsten Arc Welding for Aluminum - Titanium Boride Composite

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**Abstract:** *The main aim of this thesis is to evaluate the mechanical behavior of the gas tungsten arc welded aluminum based metal matrix composite. The material added to the aluminum is "Titanium Boride micro powder", TiB<sub>2</sub>, APS - 1-2 $\mu$ m using friction stir processing method. The material is welded using gas tungsten arc welding process. Then the welded pieces are evaluated for chemical analysis, mechanical testing like tensile, and impact and hardness tests.*

**Keywords:** Metal matrix composites, GasMetal Arc Welding, Gas Tungsten

## 1. Introduction

MMC (Metal matrix composites) are metals reinforced with other metal, ceramic or organic compounds. They are made by dispersing the reinforcements in the metal matrix. Reinforcements are usually done to improve the properties of the base metal like strength, stiffness, conductivity, etc

**Aluminum Metal Matrix Composite:** The automotive industry recognizes that weight reduction and improved engine efficiency will make the greatest contribution to improved fuel economy with current power trains. This is evidenced by the increased use of aluminum alloys in engine and chassis components. Aluminum and magnesium castings in this sector have grown in leaps and bounds over the past five years to help engineers design and manufacture more fuel efficient cars. MMC's desirable properties result from the presence of small, high strength ceramic particles, whiskers or fibers uniformly distributed throughout the aluminum alloy matrix. Aluminum MMC castings are economically competitive with iron and steel castings in many cases. However, the presence of these wear resistant particles significantly reduces the machinability of the alloys, making machining costs higher due mainly to increased tool wear. As a result, the application of cast MMCs to components requiring a large amount of secondary machining has been somewhat stifled.

**Titanium DiBoride:** It is an extremely hard ceramic which has excellent heat conductivity, oxidation stability and resistance to mechanical erosion. TiB<sub>2</sub> is also a reasonable electrical conductor, so it can be used as a cathode material in aluminium smelting and can be shaped by electrical discharge machining.

**Gas-Tungsten Arc Welding (GTAW):** This process is also known as tungsten-inert gas (TIG) welding. This is similar to the GasMetal Arc Welding process. Difference being the electrode is non-consumable and does not provide filler metal in this case. A gas shield (usually inert gas) is used as in the GMAW process. If the filler metal is required, an auxiliary rod is used.

## 2. Literature Review

Investigations on aluminium matrix composites by previous researchers. [1] V. Massardier, R. Fougères, P. Merle, the tensile properties of an aluminium-based metal matrix composite reinforced with  $\alpha$ -aluminum platelets were investigated from an experimental and a theoretical point of view. An increase in Young modulus, 0,2% proof stress, flow stress and ultimate tensile strength was observed over the unreinforced metal. These improvements were obtained at the expense of the tensile ductility.

The experimental results were analyzed using both a dislocation model and a continuum model based on an iterative Eshelby method. [2] C. Saravanan, K. Subramanian, Karaikudi V. Ananda Krishnan, R. Sankara Narayanan, the combined effect of reinforcements on Aluminium Metal Matrix composites with individual and multiple particulate reinforcements like Hybrid Metal matrix composites are finding increased applications in aerospace, automobile, space, underwater, and transportation applications. This is mainly due to improved mechanical and tribological properties like strength, stiffness, abrasion, impact resistance and wear resistance. In the present scenario, a lot of research activities were on pipe line. This paper guides the researchers and engineers towards proper selection of materials by their properties in the relevant field and different techniques involved in manufacturing of metal matrix composites, particularly on the liquid state metal processing technique.

## 3. Proposed Methodology

In this project friction stir processing method is used to mix the Aluminium HE-30 and Titanium diboride in which Aluminium HE-30 is 750grams and TiB<sub>2</sub> is 15grams.

### a) Procedure of Friction Stir Processing and Casting

The friction stir processing has done in an open furnace where the small granules of Al 6082 were melt and TiB<sub>2</sub> has mixed.



Figure 1: Al 6082 granules were melting in the furnace.



Figure 2: In the melted Al6082 TiB<sub>2</sub> of 15 grams was mixing



Figure 3: Die which is used to pour the molten material of Al6082 and TiB<sub>2</sub>



Figure 4: The plates removed from the die.

#### b) Gas Tungsten Arc Welding of AlTiB<sub>2</sub> Pieces Experimental Work

The work pieces are cut into the required dimension (55mm\*60mm\*6mm) and they are welded by TIG process. The plates have been welded by the tungsten inert gas welding where the inert gas was Argon.

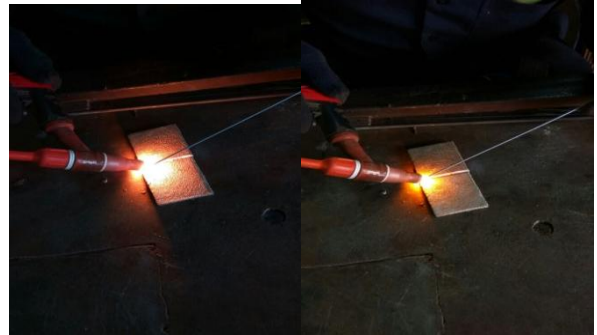


Figure 5: The plates are joining by means of TIG where an electrode and the torch can be seen.

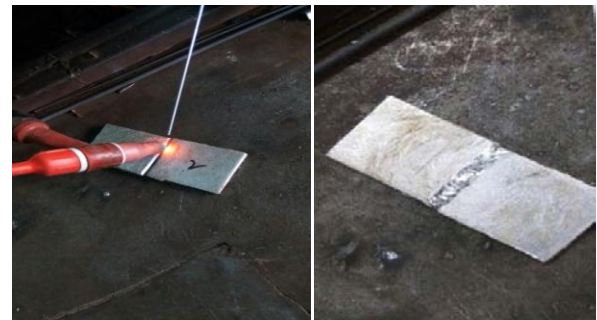


Figure 6: The plates before and after welding

#### 4. Results and Discussions

After performing Gas Tungsten arc welding on the work pieces, they are taken to the lab to test the mechanical properties like tensile test, impact, and hardness. Before that it has undergone for the chemical composition analysis.

##### Chemical Analysis Test Report

Equipment used: Optical Emission spectrometer.

Test Reference: ASTM E1251-07

**Composition of the test pieces**

S.No	Sample	Cu%	Mg%	Si%	Mn%	Fe%	Zn%	Ti% + Bi2	Cr%	B%	Al%
01	Al composite	0.091	0.511	1.01	0.672	0.336	0.032	0.51	0.013	0.35	Rem

**Composition of original Alloy 6082**

S.No	Sample	Cu%	Mg%	Si%	Mn%	Fe%	Zn%	Ti%	Cr%	B%	Al%
01	Al composite	0.0-0.1	0.6-1.2	0.7-0.3	0.4-1	0.0-0.5	0.0-0.2	0.0-0.1	0.0-0.25	0.0-0.15	Rem

By comparing the compositions of the original Al6082 with that of welded AlTiB<sub>2</sub> piece, the percentage of the Titanium is increased.

**Tensile Test Results**

**Equipment used:** Universal testing machine

**AlTiB<sub>2</sub> Welded Piece**

Ultimate Tensile Strength: 28.844 MPa

Elongation% : 3.800

**Original Al 6082**

Ultimate Tensile Strength: 300MPa

Elongation% :9

By observing the tensile test results, the strength of the welded piece and the elongation is reducing by adding Titanium diboride.

**Hardness Test**

**BrinellHardness: BHN**

Indenter : 5mm

Load Applied : 250 Kgs

Result : 62.50 BHN

**Original Al 6082**

BrinellHardness – 91BHN

By observing the hardness results, the Brinell hardness value is reducing by adding Titanium diboride.

**Impact Test**

**Equipment used :Krystal Elmec**

Notch Depth: 2mm

Type of Impact : CHARPY-V

Notch Angle : 45 degree

Impact Test Temp: At room temperature

**Result**

In longitudinal direction -6 Joules.

**5. Conclusion**

The mechanical properties of welded AlTiB<sub>2</sub> pieces are investigated for chemical analysis, tensile test, hardness and impact tests and compared with that of original Aluminum 6082 material. By comparing the compositions of the original Al6082 with that of welded AlTiB<sub>2</sub> piece, the percentage of the Titanium is increased. By observing the tensile test results, the strength of the welded piece and the elongation is reducing by adding Titanium diboride. By observing the hardness results, the Brinell hardness value is reducing by adding Titanium diboride.

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