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Effect of Mechanical Analysis of Magnesium AZ 80 Alloy and Aluminium 7075 Alloy Using Diffusion Bonding

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Abstract--- *The principal problem when joining magnesium alloy (Mg) and aluminium alloy (Al) lies within the existence of formation of oxide films and brittle intermetallic within the bond region. But diffusion welding is accustomed be part of these alloys while not a lot of problem. In this investigation, an attempt was made to analyse the mechanical properties such as lap shear strength, Ram tensile strength and microhardness for diffusion bonding of AZ80 magnesium (Mg) and AA7075 aluminium (Al) dissimilar materials. The bonding quality of the joints was checked by microstructure analysis. This work is conducted to obtain better understanding and characterization of the diffusion bonding of similar and dissimilar metals. It also aimed to obtain optimum parameters for diffusion bonding of aluminium coating over magnesium alloy with Aluminium alloy. This work is conducted to obtain better understanding and characterization of the diffusion bonding of similar and dissimilar metals. It also aimed to obtain optimum parameters for diffusion bonding of aluminum coating over magnesium alloy with aluminum alloy. These two metals are jointed inside the die after finishing surface treatment.*

Keywords--- *Mechanical Analysis, Magnesium AZ, Diffusion Bonding.*

I. INTRODUCTION

Diffusion bonding is a solid state joining process where in the principal mechanism is inter diffusion of atoms across the interface. Diffusion bonding of most metals is conducted in vacuum or in an inert atmosphere (normally dry nitrogen, argon or helium) in order to reduce detrimental oxidation of the faying surfaces. Another way to define the diffusion bonding is a solid state welding process by which two polished surfaces are joined at elevated temperature and under applied pressure.

Table 1: Mechanical properties of the base metal

Mechanical Properties	Mg alloy	Al alloy
Density (Kg/m^3)	1.78x10^3	2.9x10^3
Ultimate Tensile strength (MPa)	351	580
Elongation (%)	17	11
Shear strength (MPa)	199	342

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Aluminium is the most copious metal available in the earth's crust. It is also a consumer metal of great importance. This becomes a strong competitor for steel in various Engineering applications. The 7075 aluminium alloys are widely used due to their excellent combination of mechanical properties and corrosion resistance.

The mechanical properties and the chemical composition of both aluminium and magnesium alloys are given in the tables 1 and 2.

Table 2: Chemical Composition of the base metal

Chemical Compositions	AZ80 Mg alloy	AA7075 Al alloy
Al	8.36	90.02
Zn	0.75	5.1
Mn	0.26	0.30
Fe	0.0037	0.50
Ti	-	0.20
Si	0.033	0.40
Cu	0.002	1.2
Ni	0.00056	-
Cr	-	0.18
Mg	90.591	2.1

II. EXPERIMENTAL ANALYSIS

Rectangular formed specimens (45 millimeter x 45 millimeter) were machined from rolled plates of ten mm thickness metallic element (AZ80) and metal (AA7075) alloys. The polished and with chemicals treated specimens were stacked in a very die created of 316L stainless-steel and also the entire diffusion bonding setup, shown in Fig. 2, was inserted into a chamber (vacuum pressure of a hundred and forty pressure unit is maintained). The specimens area unit het up to the bonding temperature victimisation induction chamber with a heating rate of 250C/min; parallel the specified pressure was applied. Once the completion of bonding, the samples area unit cooled to temperature before removal from the chamber. Twenty seven trials of dissimilar joints area unit fictitious victimisation completely different combos of bonding temperature, bonding pressure and holding time.

Effect of Pressure

Table 3: Bonded samples

Sl. No	Temperature	Pressure	Time	Remarks
1.	400	2	15	Not Bonded
2.	400	5	15	Bonded
3.	400	10	15	Bonded
4.	400	15	15	Bonded
5.	400	20	15	Bonded
6.	400	25	15	Deformed

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(a) Not Bonded Specimen

(b) Bonded Specimen

(c) Deformed Specimen

III. Results And Discussion

The middle layer of AZ80 Mg alloy/AA7075 Al alloy diffusion warranted joint made the plain diffusion between the Az80 Mg alloy substrate and therefore the AA7075 Al alloy substrate within the condition of the diffusion bonding. After the bonding method, the macro deformation isn't ascertained at the warranted samples. All warranted samples were made with sound bonding with none small pores, micro-crack and compound. The new bright section is made at the interface in keeping with Mg-Al section diagram, the new section of Mg-Al intemetallics is made once the holding pressure is 2 MPa to 25 MPa. There is an apparent boundary between the AA7075 Al alloy substrate and therefore the diffusion zone. But the boundary isn't obvious between the Az80 Mg alloy substrate and therefore the diffusion zone. The specimens are prepared for Lap shear and Ram Tensile test.

Lap shear test specimen

Before Testing

After Testing

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Ram Tensile test specimen

Table 4: Lap shear and Ram Tensile Test Results

Sample No	Bonding Temperature ˚C	Bonding Pressure MPa	Bonding Time min	Lap Shear MPa	Ram Tensile MPa
1.	**400**	**5**	**15**	**13**	**19**
2.	**400**	**10**	**15**	**23**	**29**
3.	**400**	**15**	**15**	**21**	**31**
4.	**400**	**20**	**15**	**20**	**27**

Table 5: Results of Micro hardness Test

Sample No	Bonding Temperature ˚C	Bonding Pressure MPa	Bonding Time min	X-axis Hv	Y-axis	
					Al Side Hv	Mg Side Hv
5.	**400**	**5**	**15**	**96.833**	**85.6**	**97.7**
6.	**400**	**10**	**15**	**70.833**	**75.4**	**83.3**
7.	**400**	**15**	**15**	**102.066**	**66.7**	**102**
8.	**400**	**20**	**15**	**71.366**	**84.3**	**106**

IV. CONCLUSION

The optimization of bonding parameters for diffusion bonding magnesium AZ80 alloy and aluminum AA7075 alloy are to be diffused in a diffusion bonding machine and the die is kept inside the diffusion bonding machine by varying the time, temperature, pressure by means of load. Before making diffusion bonding equipment, experiments are conducted with high expensive and simple fixture which is kept inside an induction furnace in clamping position to get diffusion bonded joints. Hot press diffusion bonding equipment is fabricated and verified with experiments so that it is capable of rendering accurate diffusion bonding joints with facilities to measure parameters and to investigate the super plastic diffusion bonding joints. This method is devised to study the physical phenomena that have significant influence on diffusion bonding such as time, temperature, pressure on joints and metallurgical characteristics. Ram Tensile and Lap shear tests are to be conducted and micro hardness test are also conducted. For the diffusion bonding of Az80 Magnesium alloy and AA7075 Aluminum alloy, the maximum shear strength was obtained for the specimen bonded at 400^{o}C,15 MPa and 15 minutes. The tensile shear strength of the bonded specimens was found to be increased with increasing temperature until a maximum value is reached beyond which it decreased.

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