ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 11, November 2017

Enhancing The Property Of Brass By Friction Stir Process

[1] D Kumaravel, [2] V.K.Bupesh Raja, [3] Rangasamudram Anil Kumar Reddy
[1-3] Sathyabama University, Chennai, Tamil Nadu, India

Abstract: **-- Friction stir processing is an advanced machining process to improve the property of component . This is produced by forcibly inserting a non-consumable tool into the work piece and revolving the tool in a stirring motion as it is pushed laterally through the work piece. This research is to improve the mechanical property of brass by coating aluminum oxide by friction stir processing. M2 tool is used at a speed of 710 rpm and feed of 12 mm / min. Material after the process was subjected to tensile test, hardness test, salt spray corrosion test and chemical analysis. Improvement in hardness was obtain in the surface composite layer. Beside, strength of the processed brass material also increased as compare to the normal brass work piece.**

I. INTRODUCTION

Friction stir welding is a solid-state joining process that uses a non-consumable tool to join two facing work pieces without melting the work piece material. Heat is generated by friction between the rotating tool and the work piece material, which leads to a softened region near the FSW tool. While the tool is traversed along the joint line, it mechanically intermixes the two pieces of metal and forges the hot and softened metal by the mechanical pressure, which is applied by the tool, much like joining clay, or dough. It is primarily used on wrought or extruded aluminium and particularly for structures which need very high weld strength. In friction stir processing, a rotating tool is used with a pin and a shoulder to a single piece of material to make specific property enhancement, such as improving the material's toughness or flexibility, in a specific area in the micro-structure of the material via fine grain of a second material with properties that improve the first. Friction between the tool and work pieces results in localized heating that softens and plasticizes the work piece. A volume of processed material is produce by movement of materials from the front of the pin to the back of the pin. During this process, the material undergoes intense plastic deformation and this results in significant grain refinement. FSP changes physical properties without changing physical state which helps engineers create things such as high strain rate super plasticity. The grain refinement occurs on the base material improving properties of the first material, while mixing with the second material. This causes for the base material's properties. This allows for a variety of materials to be altered to be changed for things that may require other difficult to acquire conditions. The processes branches off of friction stir welding which uses the same process to weld two pieces of different materials together without heating, melting or having to change the material physical state.

II. PROBLEM IDENTIFICATION

Metallic parts produced by casting are comparatively inexpensive, but are often subject to metallurgical flaws like porosity and microstructure defects. Friction stir processing can be used to introduce a wrought microstructure into a cast component and eliminate many of the defects. By vigorously stirring a cast metal part to homogenize it and reduce the grain size, the ductility and strength are increased. Friction stir processing can also be used to improve the microstructural properties of powder metal objects. In particular, when dealing with aluminium powder metal alloys, the aluminium oxide film on the surface of each granule is detrimental to the ductility, fatigue properties and fracture toughness of the work piece. Brass has a wide range of application because of its bright gold-like appearance such as in locks, gears, bearings, doorknobs, ammunition casings and valves for plumbing and electrical applications. These doors can be scratched or dented which gives bad look. Brass doors are suitable for only interiors as they fade away in harsh weather conditions. They require polishing to protect their surface. Color of brass doors fades with the passage of time. These doors have warm feeling in summer and cold in winter when they are touched. But brass has low mechanical and chemical properties such as low strength, hardness, corrosion resistance. Objective of this research is to enhancing the hardness and corrosion resistance of brass using coating aluminium oxide by friction stir processing.

III. MATERIAL

3.1. Base material

Brass is a metal alloy made of copper and zinc. Brass is used for applications where low friction is required. Due to its low hardness and strength it is not used in high wear applications. In order to increase the strength of the brass metal, friction stir process is selected.

Table 1. Properties of brass

3.2. Tool Material

M_2 material is selected as a friction stir tool. Since, the hardness and melting point is suitable to machine the brass plate M_2 is used to make friction stir process.

Table 2. Mechanical properties of M_2 tool

Properties	Values
Density (g/cm^3)	8.16
Hardness (HRC)	65
Melting point (^oC)	2380
Elastic modules (GPa)	190-210

Figure 1. M_2 tool

3.3. Coating material

Aluminium oxide is a chemical compound of aluminium and oxygen with the chemical formula Al_2O_3. Metallic aluminium is very reactive with atmospheric oxygen and a thin passivation layer of aluminium oxide forms on any exposed aluminium surface. This layer protects the metal from further oxidation.

Table 3. Properties of Al2O3

Properties	Values
Hardness (Kg/mm^2)	1175
Maximum used temperature (^oc)	1700
Density (g/cm^3)	3.69
Elastic modules (GPa)	300
Compressive strength (MPa)	3100
Flexible Strength (MPa)	330

3. Experimentation

Commercial brass plate with 61% copper, 37% zinc, 1% lead, 1% iron of thickness 5 mm was selected as work piece material for the present experiment. Brass plate was cut with dimension of 100 mm x 140 mm with the help of band-saw and grinding done at the edge. After that surfaces are polished with emery paper to remove any kind of external material. M_2 cylindrical tool with pin length 3 mm, diameter of 6 mm and shoulder of 25 mm diameter was used to coat the powders on the surface. Processing parameters of rotational speed of 710 rpm and a travel speed of 12 mm / min were employed. After sample preparation, brass plate is fixed in the working table on a fixer with flexible clamp side by side and then Aluminium oxide powder (Al_2O_3) was spread uniformly on the surface of brass plate and processing was done so that aluminium oxide powder get coated on the surface of brass. Before selecting the correct rotational speed and travel speed several trails were made for getting the good surface finishing. Finally a rotating speed of 710 rpm and travelling speed of 12 mm / min was selected for the process. At this parameter the tool was forcibly inserting into the work piece and revolving the tool in a stirring motion as it is pushed laterally through the work piece. During this process aluminium powder get coated over the surface of the work piece and get hardened.

Figure 2. Processing of Brass plate

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 2, Issue 11, November 2017

IV. TESTING AND RESULT

4.1. Tensile Test

Tensile test is used to find the strength of the work piece in order to withstand the tensile force. After the brass plate was coated with Aluminium oxide it has been for machining and then it was given for the tensile test and results were obtain from the test.materail having high strength is

With the help of UTM machine the following result is obtained.

Table 4. Tensile test result

Parameters	Values
Ultimate tensile strength (MPa)	284
Yield strength (MPa)	186
Elongation (%)	25.50

4.2. Hardness traverse survey

Hardness traverse survey is used to find the hardness of the material along the surface in order to obtain uniform hardness. In this research work the coated brass material is subjected to hardness traverse survey and reading is taken. Form the reading, it is shown that there is an increase in a hardness as compare to the normal metal. Hence, with the help of friction stir processing method property of brass metal is increased. By increasing the property of brass, the application of brass will be increased. Since, the cost of the material is low as compare with other material brass will be utilized in various purpose.

Table 5. Hardness traverse test result

Distance	Hardness	Distance	Hardness
0.1	142.5	0.6	114.4
0.2	119.9	0.7	127.3
0.3	115.8	0.8	140.7
0.4	112.8	0.9	132.3
0.5	111.7	1.0	114.5

4.3. Salt Spray Test

The apparatus for testing consists of a closed testing cabinet/chamber, where a salt water (5% NaCl) solution is atomized by means of spray nozzle using pressurized air. This produces a corrosive environment of dense salt water fog in the chamber, so that test samples exposed to this environment are subjected to severely corrosive conditions. Chamber volumes vary from supplier to supplier. If there is a minimum volume required by a particular salt spray test standard, this will be clearly stated and should be complied with. There is a general historical consensus that larger chambers can provide a more homogeneous testing environment. After the brass plate was coated with Aluminium oxide it has been given for the salt spray corrosion test and following results were obtain from the test.

Table 6. Salt spray test as per ASTM B117

S.no	Parameters	Results
1	pH Solution	6.85-6.89
2	Air Pressure	14-15 psi
3	Concentration of sodium chloride	5.1-5.2%
4	Chamber temperature	34.6-35.3° C
5	Collection of solution per hour	1.2~1.4ml

4.4. Micro hardness test

The micro hardness test is done in the processed brass material and the structure is shown below. In this structure, the inside bond of the material is increased and the structure become compact due to strong bond from the normal brass and the material hardness is increased.

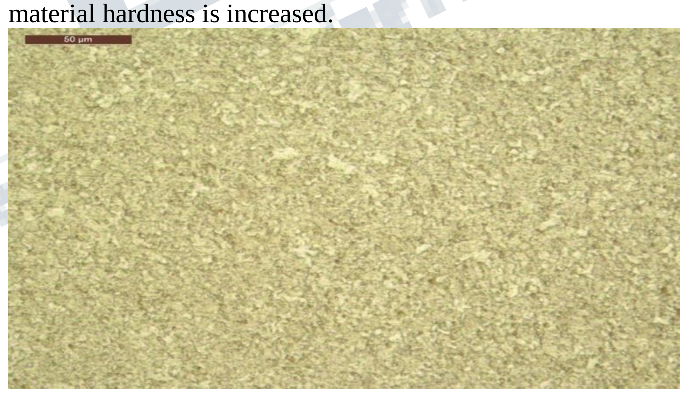

Figure 3. Micro hardness test coated (500x)

4.5 Chemical Analysis Test

Optical emission spectroscopy (OES) or atomic emission spectroscopy (AES) are an important tool for fast and accurate elemental analysis of metals. Optical emission spectroscopy provides a non-evasive probe to investigate atoms, ions and molecules within a plasma. It can provide information about properties, such as (excited state) species densities, electron-atom, atom-atom and ion-atom coalitional effects, energy distribution of species, charge transfer between plasma constituents, and electric and magnetic fields.

Table 7. Observation of chemical analysis

Elements	Normal brass %	Friction stirred brass %
Cu	61.64	60.59
Zn	38.28	39.33
Fe	0.049	0.041
Pb	0.004	0.022
Al	0.006	0.172
S	0.003	0.004
Sn	0.017	0.020
P	0.001	0.005
Ni	0.004	0.004

V. CONCLUSION

Friction stir processing of brass by coating with Aluminium oxide is able to increase the hardness and refine the microstructure. From this project, the hardness of the coated brass was increased as compare to the normal brass. Particles of Aluminium oxide was found to affect the final hardness and corrosion resistance of brass. Tensile test, hardness traverse test and micro hardness test to check and compare their values. The result showed that the ultimate tensile strength of normal brass which was 260.5MPa was increased to 284Mpa after Friction stir processing. Significant improvement in the hardness result was found after processing, the hardness was increased by 7.07% as compare with the normal brass. According to the micro hardness test the microstructure get compacts after processing which indicates that the hardness was increased significantly as compared to normal brass. The salt spray corrosion test was done, which shows that after 24 hours the normal brass got a discoloured corroded appearance where as the coated brass was corrosion free. Hence friction stir processing is an effective strategy to enhance the hardness of brass to be used for high performance engineering applications.

REFERENCES

[1] Adem kurt, Llyas Uygur, Eren Cete, Surface modification of aluminium by friction stir processing, Journal of Materials Processing Technology, (2011) 313–317.

[2] Chunjie Huang, Wenya L, Yan Feng, Yingchun Xie, Marie-Pierre Planche, Hanlin Liao,Ghislain Montavon, Microstructure evolution and mechanical properties enhancement of a cold-sprayed Cu Zn alloy coating with friction stir processing, Advanced Engineering Technology, 200-211.

[3] Francesca Guidi, Ghiuseppe Moretti, Electrochemical anticorrosion performance evaluation of Al_2O_3 coatings deposited by MOCVD on an industrial brass substrate, Materials Science and Engineering, 6971-6980.

[4] Hong-Qiang Fan, Da-Hai Xia, Mou-Cheng Li, Investigate Al_2O_3 / TiO_2 particle-reinforced copper through plasma spraying and friction stir processing.

[5] Midhun Antony, Bijin T Pavithran, Issac Thamban, Friction stir processing Aluminium alloy AA6061, International Journal of Emerging Technology and Advanced Volume 3, Issue 1, January 2013

[6] Weglowski. M, Friction Stir Processing of an AlSi6Cu4 cast aluminium alloy, Journal of Materials Processing Technology, 128-136.

[7] Emel Taban, Jerry E. Gould, John C. Lippold, Dissimilar friction stir welding of 6061-T6 aluminum and AISI 1018 steel: Properties and microstructural characterization, Materials and Design, 2305–2311