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EXPERIMENTAL AND INVESTIGATION OF ALUMINIUM, SILICONAND GUNMETALCOMPOSITE GEAR FOR ROBOTIC ARM

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ABSTRACT

In this project composite material is formed by combining multiple materials in order toachieve superior mechanical properties. In this case, aluminum silicone and gunmetal arecombinedtogethertocreateanalloythatpossessesexcellentwear-resistance,highstrength,low density, and enhanced thermal stability. The use of these materials together will also beable to reduce manufacturing costs whilst maintaining performance integrity. This alloy isperfect for engineering applications such as precision parts, bearings and gears under harshoperating conditions like marine environments or high-temperature aircraft engines. Finallygearismadeupofaluminium,silicone,gunmetalmaterialsandcompressible,hardness,toughness test was made, this type of gear is very useful for highly corrosion areas to avoidcorrosions.

INTRODUCTION

A composite material can be defined as a combination of two or more materialsthat results in better properties than those of the individual components usedalone. In contrast to metallic alloys, each material retains its separate chemical,physical, and mechanical properties. The two constituents are reinforcement anda

matrix.Themainadvantagesofcompositematerials are their high strength and stiffness,combinedwithlowdensity,whencomparedwithbulkmaterials,allowing fora weightreductioninthefinishedpart.The reinforcing phase provides the strength and stiffness. In most cases,thereinforcementisharder,stronger,andstifferthanthematrix.The reinforcement is usually a fiber or a particulate. Particulate composites havedimensionsthatareapproximatelyequalinalldirections.Theymaybespherical,platelets, or any other regular or irregular geometry. Particulate composites tendto be much weaker and less stiff than continuous fiber composites, but they areusually much less expensive. Particulate reinforced composites usually containless reinforcement (up to 40 to 50 volume percent) due to processing difficultiesand brittleness. A fiber has a length that is much greater than its diameter. Thelength-to-diameter(l/d)ratioisknownastheaspectratioand canvarygreatly.cheap and easysolutionforfiredetection.

LITERATURE REVIEW

[1]DheerendraKumarDwivedisaysthattheinfluenceof slidinginterfacetemperature on friction and wear behavior of cast Al–(4–20%) Si–0.3% Mg has beenreported. Wear and friction tests were performed under dry sliding conditions usingpinondisctypeoffrictionandwearmonitorwiththedataacquisitionsystemconforming to ASTM G99 standard. It was found that sliding interface temperaturehas close relationwithwearand frictionresponse of these alloys. Initial rise ininterfacetemperaturereducesthewearrateandassoonasa criticaltemperature(CT) iscrossed,wearrateabruptlyincreasesincaseofallthecompositionsusedinthisinvestigation.

[2]Rajneesh Kumar Vermasays that in recent years aluminium alloys are widelyused inautomotive industries. This is particularly due to the real need to weightsaving for more reduction of fuel consumption. The typical alloying elements arecopper,magnesium,manganese,silicon,andzinc.Surfacesofaluminiumalloyshavea brilliant luster in dry environment due to the formation of a shielding layer ofaluminium oxide. Aluminium alloys of the 4xxx, 5xxx and 6xxx series, containingmajor elemental additives of Mg, CuandSi, are now being used to replace steelpanelsifvariousautomobileindustries.Duetosuchreasons,theseAlloysweresubject of several scientific studies in the past few years. Effects of Alloying Elementsplay an important role in manufacturing of engine parts. According to the requirementthey classified as major elements and minor elements. Among these silicon plays animportant role inmanufacturing of engineparts.

[3]M.Guptasays that three aluminum–silicon alloys containing 7, 10 and 19 wt %silicon were synthesized using a novel technique commonly known as disintegratedmelt deposition technique. The results following processing revealed that a yield of atleast 80% can be achieved after defacing the shrinkage cavity from the as-processedingots.Microstructuralcharacterizationstudies conductedontheas-processedsamples revealed an increase in the volume fraction of porosity with an increase insilicon content. Porosity levels of 1.07, 1.51 and 2.65% attained in the case of Al–7Si,Al–10Si, and Al–19Si alloys indicates the near-net shape forming capability of thedisintegrated melt deposition technique. The results of aging studies conducted on thealuminum–siliconalloysrevealedsimilaragingkineticsirrespectiveof differentsiliconcontent.Resultsofambienttemperaturemechanicaltestsdemonstratean increase in matrix micro hardness and 0.2% yield stress and decrease in ductility with an increase in silicon content in aluminum.ZYUJ

MATERIALS AND METHODS

ROBOTIC ARM

A robotic arm is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement.

The links of the manipulator can be considered to form a kinematic chain. The terminus of the kinematic chain of the manipulator is called the end effector and it is analogous to the human hand the end effector, or robotic hand, can be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application. For example, robot arms in automotive assembly lines perform a variety of tasks such as welding and parts rotation and placement

designed to conduct bomb disarmament and disposal

during assembly. In some circumstances, close emulation of the human hand is desired, as in robots

ALUMINIUM

Aluminium is a light metal (ρ = 2.7 g/cc); is easily machinable has wide variety of surface

finishes; good electrical and thermal conductivities; highly reflective to heatand light.

- Al and its alloys - high strength-to-weight ratio (high specific strength) owing to low density.
- Such materials are widely used in aerospace and automotive applications where weight savings are needed for better fuel efficiency and performance.
- Al-Li alloys are lightest among all Al alloys and find wide applications in the aerospace industry.

SILICON CARBIDE

Silicon carbide is formed in two ways, reaction bonding and sintering. Each forming method greatly affects the end microstructure. Reaction bonded SiC is made by infiltrating compact Gun Metal

Modified gunmetal contains lead in addition to the zinc; it is typically composedof 86% copper, 9.5% tin, 2.5% lead and 2% zinc. It is used for gears and bearings.
U.S. Government bronze specification G C90500 is composed of 88% copper, 10% tin and 2% zinc.

For other uses, see Gunmetal

condition between reinforcing phase and matrix. These techniques has to ensure uniform distribution of the reinforcing material in the matrix and formation of good bond between

(disambiguation). Gunmetal, also known as red brass in the United States, is a type of bronze – an alloy of copper, tin and zinc. Proportions vary by source, but 88% copper, 8-10% tin and 2-4% zinc is an approximation. Originally used chiefly for making guns, it was eventually superseded in this department by steel. Gunmetal, which casts and machines well and is resistant to corrosion from steam and salt water, is used to make steam and hydraulic castings, valves, gears, statues and various small objects, such as buttons. It has a tensile strength of 221 to 310 MPa, a specific gravity of 8.7, a density 8,719 kg/m3, a Brinell hardness of 65 to 74, and a melting point of around1000 degrees Celsius

METHODS

STIR CASTING PROCESS STUDIES

Fabrication techniques affect the microstructure, the distribution of the reinforcing materials and interfacial bond

matrix and reinforcing material, to obtain MMCs with optimum properties. There are several fabrication techniques available to manufacture different MMC. Depending on the choice of matrix and reinforcement material, the fabrication techniques can vary considerably. According to fabrication methods can be divided into three types. These are solid phase process, liquid phase process and semi solid fabrication process.

Among the variety of manufacturing processes available for discontinuous metal matrix composite, stir casting is generally accepted as a particularly promising route, because of low cost. lie in its simplicity, flexibility and applicability to the large quantity production. This semi solid metallurgy technique is the most economical of all available routes for MMC Production. It allows very large sized components to be fabricated, and is able to sustain high productivity rates. Has shown that the cost of preparing composite materials using a casting method is about one third to one half that of competing methods

TYMelting of Alloy

In stir casting process the following procedure was adopted for the preparation of composites. Explains the stir casting process in detail. Alloy is cut and weighed to obtain the correct weight as per the stoichio metric calculations. The metals are then taken in to a crucible along with the coverall. The furnace is heated to a temperature of 800 C and is constantly maintained at that temperature throughout the process.

Preheating of alloy

Addition of Coverall Powder

The flux used is Coverall. It is the composition of Potassium chloride (KCl) + Nitric acid (HNO3), its function is to avoid oxidation. Coverall powder is added twice during the casting process. Initially, when the ingots are placed in the crucible, later while stirring of preheated alloy particles. The recommended amount that is to be added is 250gm for a melt of 50kg.

Addition of Degasser Powder

Degasser powder is added to the molten metal when it reaches a temperature of 800 C. The recommended amount to be added is 250gm for a melt of 50Kg. Degasser powder reduces blow holes formed during the casting process. The reasons for adding degasser powder are as below

- When alloy is in the molten state, it tries to absorb hydrogen from the atmosphere.
- When the absorbed hydrogen is unable to escape from the molten metal, it results in the formation of blow holes.
- When coverall 65 is added, it forms a thin film over the molten metal and prevents contact of molten metal with the atmosphere.
- When degasser tablets is added to molten metal, the chlorine present in these tablets react with hydrogen in the molten metal and form hydrochloric acid which dissolves in the molten metal, thereby reducing blow holes.

Pouring of Molten Metal

The material is stirred with 300 rpm for thirty minutes. The stirred metal is then slowly poured into the die which is preheated to a temperature of 973 C. The die is allowed to cool in air for two hours and then the specimen is removed.

Solution Treatment

During casting low cooling rate of the alloy allows for the strengthening of alloy phase to precipitate out of solution and grow into large incoherent phases within the matrix. In the as cast structure, the large, incoherent nature of the phase doeslittle to increase the strength of the alloy. To obtain finely dispersed AL-Si and gunmetal a solution heat treatment should be conducted on the alloy.

Design of spur gear

Spur gear or straight cut gear are the simplest type of gear. The consist of a cylinder or disc with teeth projecting radially. Viewing the gear at 90 degrees from the shaft length the tooth faces are straight and aligned parallel to the axis of rotation . Looking down the length of the shaft a tooth cross section is usuallynot triangular. Instead of being straight the sites of cross section of curved form to achieve constant drive ratio. Spur gears mesh together correctly only if fitted to the parallel shaft. No axle trust is created by the tooth loads the spur gears are excellent at moderate speeds but tens to be noise at high speed.

Mechanical property test

Tensile tests are performed for several reasons. The results of tensile tests are used in selecting materials for engineering applications. Tensile properties frequently are included in material specifications to ensure quality. Tensileproperties often are measured during development of new materials and processes, so that different materials and processes can be compared. Finally, tensile properties often are used to predict the behavior of a material under formsof loading other than uniaxial tension.

The strength of a material often is the primary concern. The strength of interest may be measured in terms of either the stress necessary to cause appreciable plastic deformation or the maximum stress that the material can withstand. These measures of strength are used, with appropriate caution (in the form of safety factors), in engineering design. Also of interest is the material's ductility, which is a measure of how much it can be deformed before it fractures. Rarely is ductility incorporated directly in design rather, it is included in material specifications to ensure quality and toughness.

Tensile Strength Test

The tensile test of the composites was performed as per the ASTM D3039 standards. The test was done using a universal testing machine (Tinius Olsen H10KS).The specimen of required dimension was cut from the composite cast. The test was conducted at a constant strain rate of 2 mm/min.

Tensile test is used to determine the tensile strength of the specimen, % elongation of length and % reduction of area. Tensile test is usually carried out in universal testing machine. A universal testing machine is used to test tensile strength of materials. It is named after the fact that it can perform many standard tensile and compression tests on materials, components, and structures. The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held. However, this method notonly records the change in length of the specimen but also all other extending / elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips. Once the machine is started it begins to apply an increasing load on specimen. Throughout the tests the control system and its associated software record the load and extension or compression of the specimen. Tensile test is used to find out

Hardness Test

This gives the metals ability to show resistance to indentation which show it's resistance to wear and abrasion. Hardness testing of welds and their Heat Affected Zones (HAZs) usually requires testing on a microscopic scale using a diamond indenter. The Vickers Hardness test is the predominant test method with Knoop testing being applied to HAZ testing in some instances. Hardness values referred to in this document will be reported in terms of Vickers Number, HV.

Fracture Toughness Test

The fracture toughness of the composite specimens was measured using FractureTester (MTS 810 material test system). The specimens were cut according to dimensions as specified by the ASTM E1820; this test method is for the opening mode (Mode I) of loading. The objective of this test method is to load a fatigue pre cracked test specimen as shown in Figure 8 to induce either or both of the following responses:

- Unstable crack extension, including significant pop-in, referred to as "fracture instability" in this test method;
- Stable crack extension, referred to as "stable tearing" in this test method.

Toughness determined at the point of instability. Stable tearing results in continuous fracture toughness versus crack extension relationship (R-curve) from which significant point-values may be determined. Stable tearing interrupted by fracture instability results in an R-curve up to the point of instability. This investigation split into two major computation scopes to estimate the fracture toughness and energy release rate: it include the experiment data for fiber reinforcement epoxy composites specimens. Meanwhile, the compact tension (CT) specimen was instructed according to the ASTM E 1820 standard for the fracture toughness measurement. The thickness was 10mm for all the specimens.

Merits of composite materials composites

Can be very strong and stiff, yet very light in weight, so ratios of strength-to- weight and stiffness-to-weight are several times greater than steel or aluminium

- High specific strength and
- High specific stiffness Long fatigue life
- High creep resistance ΨLow coefficient of thermal expansion
- Low density
- Low thermal conductivity
- Better wear resistance ΨImproved corrosion resistance
- Better temperature dependent behavior

Advantages of Composite Materials

- Increase in yield strength and tensile strength at room temperature and above, while maintaining the minimum ductility or rather toughness
- Low thermal expansion coefficient
- Increase in creep resistance at higher temperatures compared to that of conventional alloys Increase in friction resistance Increase in fatigue strength, especially at higher temperatures,
- Improvement of thermal shock resistance
- Improvement of corrosion resistance
- Increase in Young's modulus
- Reduction of thermal elongation.

Applications

Space craft: Antenna structures, solar reflectors, Satellite structures, Radar, Rocket engines, etc.

Aircraft: Jet engines, Turbine blades, Turbine shafts, Compressor blades, Airfoil surfaces, Wing box structures, Fan blades, Flywheels, Engine bay doors,Rotor shafts in helicopters, Helicopter transmission structures, etc.

Miscellaneous: Bearing materials, Pressure vessels, Abrasive materials, Electrical machinery, Truss members, Cutting tools, Electrical brushes, etc.

Automobile: Engines, bodies, Piston, cylinder, connecting rod, crankshafts, bearing materials, etc

CONCLUSION

Micron-sized SiC particles were incorporated into a melt of aluminium with gunmetal the aid of addition as a wetting agent to fabricate matrix composite. Two casting temperatures and stirring time were applied to focus on composite materials especially aluminum, silicon and gunmetal composites having good mechanical properties compared with the robotic arm materials. It is used in various industrial application these materials having light weight along with high hardness. It with stand high load compare with the existing materials are most applicable in the engineering products instead of existing materials. Finally it was concluded that the percentage of al-si-Gunmetal increases automatically the hardness strength increased.

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