Experimental Investigation of Mechanical Properties of Tin Reinforced with Aluminium (6061) Composite and Scanning Electron Microscope Analysis

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ABSTRACT

The present work is an experimental investigation for the mechanical properties of tin reinforced aluminium alloy (Al 6061) composites samples, processed by stir casting method. Four composites of aluminium alloy 6061with tin composition varying i.e. 5%, 10%, 15% & 20% by weight were used. The aluminium alloy 6061 was procured in the form of ingot and the tin in powder form. First the aluminium alloy was melted in the furnace which was gas (LPG) fired and once a molten state was reached tin powder was introduced in the molten metal. The mixture was stirred continuously to bring about uniformity in the mixture and casted in a silica mould. Upon solidification the cast was removed, machined and tested for mechanical properties. The mechanical properties studied under this experiment are tensile test, compression test and hardness test all under room condition. Scanning electron microscope (SEM) images of all the four composite (of Al-Sn) are studied. In this experiment stir casting method was employed as it is the simplest and most effective method for castings. From the experimental readings it is found out that the hardness was consistently decreasing as tin is softer material than aluminium 6061 alloy, the tensile strength of the composite decreased for 5%,10%,15% of tin and slightly increased for 20% of tin and compression strength of the material kept on decreasing consistently as the percentage of tin increased in the material. When compared with the base pure aluminium alloy the composites specific weight decreased.

INTRODUCTION:

Composite materials (also called composition materials or shortened to composites) are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. Composite materials offer superior properties to conventional alloys for various application as they have stiffness, strength and wear resistance. The high cost and difficulty of processing these composites restricted their application and led to the development of discontinuously reinforced composites.

Aluminium (Al) is a silvery white and ductile member of the poor metal group of chemical elements. Al is abundant, light and strong metal which has found many uses. Like all composites, aluminium-matrix composites are not a single material but a family of materials whose stiffness, strength, density and thermal and electrical properties can be tailored. The matrix alloy, the reinforcement material, the volume and shape of the reinforcement, the location of reinforcement and the fabrication method can all be varied to achieve required properties. Regardless of the variations, however Al composites offer excellent thermal conductivity, higher shear strength ,excellent abrasion resistance ,high temperature operation ,no flammability, minimal attack by fuels and solvents and the ability to be formed and treated unconventional equipment.

Tin (Sn) is a chemical element with symbol Sn (for Latin: stannum) and atomic number 50. It is a main group metal in group 14 of the periodic table. Tin shows chemical similarity to both neighbouring group-14 elements, germanium and lead and has two possible oxidation states, +2 and the slightly more stable +4. Tin is the 49th most abundant element and has, with 10 stable isotopes, the largest number of stable isotopes in the periodic table. Tin is a silvery, malleable post-transition metal is not easily oxidized in air and is used to coat other metals to prevent corrosion. Tin resists corrosion from water but can be attacked by acids and alkalis. Tin can be highly polished and is used as a protective coat for other metals. In this case the formation of a protective oxide layer is used to prevent further oxidation. This oxide layer forms on pewter and other tin alloys. Tin acts as a catalyst when oxygen is in solution and helps accelerate chemical attack.

METHODOLOGY:

Batra (2007) in his research article tried to present the most well organized approach for the regional economic cooperation in Asia. The author defines Asia as ASEAN+4 which is the comprehensive of ASEAN, China, Japan, Korea and India. Trade Intensity Index has been applied in the study. The result shows that Trade Intensity Index is greater than unity in all reference period which indicate an enormous trade relationship among ASEAN+4. Further, the study also states that there is significant potentiality exist for ASEAN+4 to become a regional economic group in Asia.

Chandran (2010) in his research article made an attempt to recognize the compatible and competing areas of trade between India and ASEAN nations to synthesize their power and to mitigate their issues for further strengthen economic relationship between India and ASEAN. The author used Trade Intensity Index (TII) which is further divided into Export Intensity Index (EII) and Import Intensity Index (III). The reference period for the study has taken from 1990 to 2007. It is revealed from the study that there is intensity in India's export and imports with ASEAN because both export intensity and import intensity of India with ASEAN are greater than unity in most of the years. On the other hand, only ASEAN's export intensity is higher with India because ASEAN exports more to India than Imports. As far as ASEAN member countries are concerned, author argued that India's import intensity is less than unity with Thailand in most of the years but it improved after creation of trade agreement. India's import intensity is very high with Myanmar because Myanmar and India shares the common border with each other. The import intensity of India with Singapore and Malaysia is also greater than unity for the whole study period. Chandran (2012) in his research article tried to analyse the pattern of trade between India and ASEAN with special reference to India's fishery sector. Trade Intensity Index has been used in the study which is further divided into Export Intensity and Import Intensity Index. It is found from the study that export intensity of India is greater than unity with Indonesia, Malaysia, Myanmar, Singapore, Thailand and Vietnam. This reflects that India's export is enormous with these countries in fisheries sector. On the other hand, India's export intensity of fisheries sector changes over time with Brunei, Laos, Cambodia and Philippines. Further, India's import of fisheries is less intense with least developed countries of ASEAN namely Brunei, Laos and Cambodia.

Ohlan (2012) in his research article made an attempt to anticipate the India's trade with ASEAN countries. Trade Intensity Index (TII) has been applied in the study for the period 1980 to 2008. It is found from the study that there is significant fall in the trade intensity of India with ASEAN. The result of the TII reveals that it was 14.78 in the year 1980 which decline to 4.60 in the year 1990. There is a further declined in the TII to 4.37 in the year 2008. This indicates that ASEAN is less intensive for India as compared to rest of the world. Chakraborty (2014) made an attempt to evaluate the prospective trade impact of India-ASEAN Comprehensive Economic Cooperation Agreement (CECA) on the India in his research article. The author has used the Herfindhal Concentration (h) Index in the study to analyse the diversification or concentration of India's trade pattern with ASEAN countries for the period 2010 and 2012. A High value of h index shows less diversification of products and vice versa. It is found from the study that there is a fall in the products diversification in India's exports to Brunei, Cambodia, Indonesia, Malaysia and Myanmar. Singapore is the only country where the Concentration in India's exports has increased in the year 2012. As far as import is concern, product concentration is very high for Brunei due to the import of mineral fuel to India. The other ASEAN countries also indicate the high value of concentration index for India's import profile. The study also observed that there is a significant scope for India to diversify its exports profile upto a large extent to ASEAN countries. Jagdambe (2016) in his research article tried to measure the trade intensity of India's agricultural sector with ASEAN. Trade Intensity Index (TII) has been used in the study which is further divided into Export Intensity Index and Import Intensity Index. The period of study is taken from the year 2001 to 2013. The study reveals that both India's export intensity and import intensity in agricultural sector are greater than unity for the study period which indicates that India's agricultural trade with ASEAN

countries is more intensive than rest of the world. The paper also state that after signing of FTA between India and ASEAN, export intensity of India's agricultural sector has increased with least developed countries of ASEAN while import intensity of India's agricultural sector is low with Brunei, Cambodia and Laos because India's agriculture import from least developed nation of ASEAN is very low.
Trivedi and Vaish (2016) in their research article tried to estimate the economic effect of AIFTA. Trade Intensity indices have been applied in the study for the period 1990 to 2008. The authors concluded that values of trade intensity and export intensity index are greater than unity which reveals that there are intense trade relations between India and ASEAN but ASEAN trade relationship is more intense with India.

RESEARCH METHODOLOGY:

Fabrication of aluminium 6061 alloy and tin matrix composite.
The process consists of a crucible filled with metal charge is placed in a furnace and the metal is allowed to melt. The molten metal is removed from the furnace and poured into a preheated mould. Sand mould or metallic mould can be used for collecting the molten metal. Aluminium alloys can be melted in direct or indirect fuel fired furnaces or in an electrically heated furnace like crucible furnaces, reverberatory furnaces, pot furnaces, induction furnaces. The furnace is turned on and the temperature is set to 750ºC and placing the crucible with material inside the furnace and it is covered with wool and then the cover plate is placed on the furnace opening, after attaining the present temperature the material gets melted
The final step in the process involves grinding, sanding, or machining the component in order to achieve the desired dimensional accuracies, physical shape and surface finish.
Removing the remaining gate material, called a gate stub, is usually done using a grinder or sanding. These processes are used because their material removal rates are slow enough to control the amount of material. These steps are done prior to any final machining.

Fig: Final casted composite

Fig: machining process of casted composite

After Machining.

Scanning electron microscope images:
MODEL 1: Al6061 95%Sn 05%

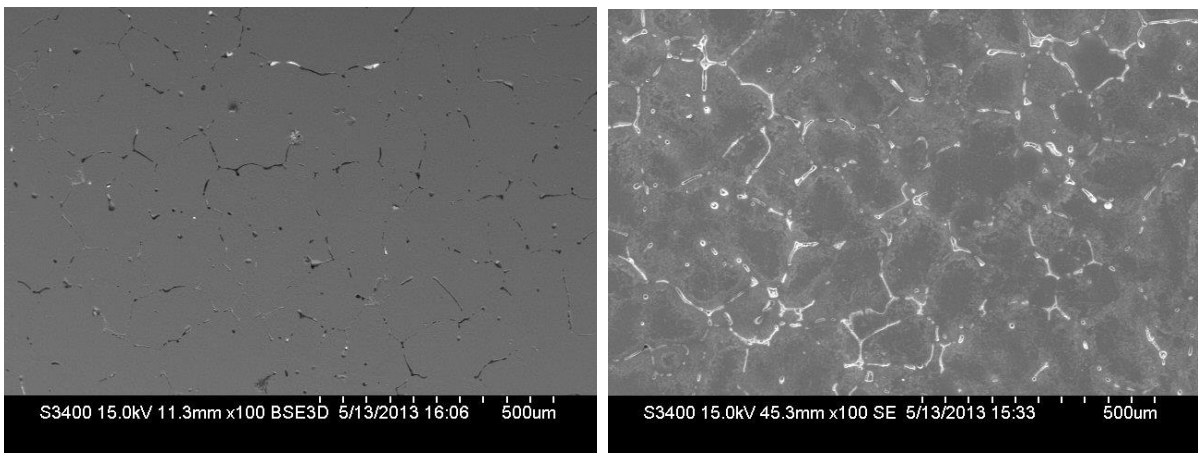

Fig. SEM images of Al6061 95%Sn 05%

Model 2:Al90%Sn10%

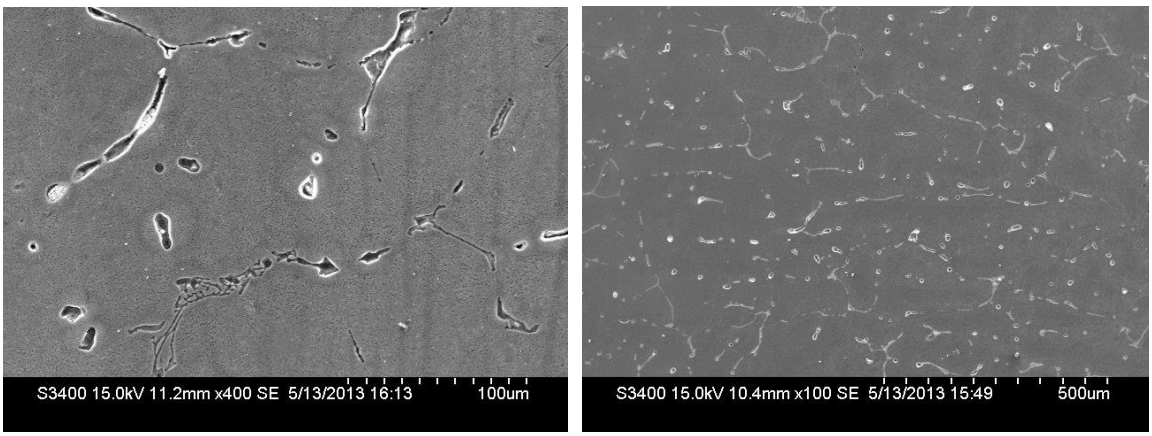

Fig. SEM images of Al6061 90%Sn10%

MODEL3: Al6061 85%Sn15%

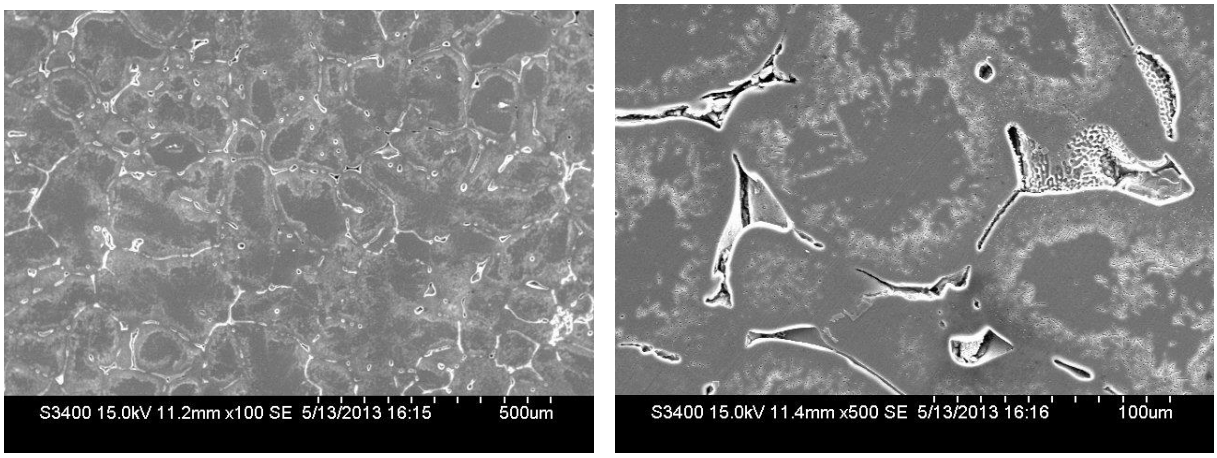

Fig. SEM images of Al6061 85%Sn15%

Model 4: Al6061 80%Sn20%

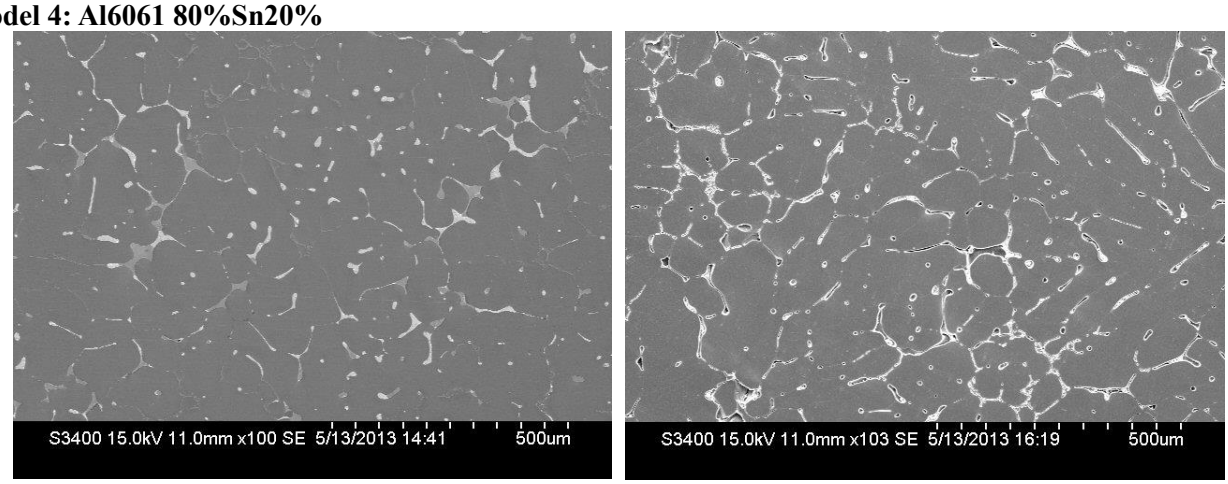

Fig. SEM images of Al6061 80%Sn20%

CONCLUSION:

The conclusions drawn from the present investigation are as follows:

- Aluminium based metal matrix composites have been successfully by stir casting technique with fairly uniform distribution of tin particles.
- For synthesizing of composite by stir casting process, stirrer design and stirrer position, stirring speed and time, particles preheating temperature, particles incorporation rate etc. are important process parameters
- During the process of the aluminium composite degassing process is a very important step otherwise porosity in the final casted composite will be more
- The SEM microscope analysis revealed that tin particulate have fairly distributed in aluminium alloy matrix .it also revealed from images that there may be some voids present in the specimen
- The results confirmed that stir casting formed Aluminium 6061 with tin reinforced composites is clearly superior to base alloy in comparison of micro hardness i.e. hardness decreases after addition of tin.

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