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Study of Thermal Properties of AA 6061and Thermal Analysis of a Fin and a Chip of AA 6061 based Particulate Metal Matrix Composites

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Abstract: ***The metal matrix composites samples are fabricated using stir casting method, thermal properties of AA 6061, AA 6061 + 5% Al2O3, AA 6061 + 5% BN, AA 6061 + 5% SiC metal matrix composites were studied by pin fin apparatus. Examine the performance of a straight fin is made of AA 6061 MMC material used for cooling an electronic chip by determining the maximum operating temperature of the chip at the steady-state condition. The temperature distribution and heat flus for four different composite materials like AA 6061 T6, AA 6061 T6 + 5% Al2O3, AA 6061 T6 + 5% BN ,AA 6061 T6 + 5% SiC was analysed. The results show the AA 6061 T6 + 5% BN composite material have the good temperature exhibiter than the other three composites. The reason for exhibiting good temperature is because of the quality of thermal conductivity. Unsteady Thermal Analyses of Fin is performed for the AA 6061 MMC material. The temperature distribution was found in the particular location of the fin structure. In this project for all the four composite materials the temperature report at an each part of the fin is vital.***

Keywords: Thermal analysis, AA6061, Fins, composite material, ANSYS

I. INTRODUCTION TO METAL MATRIX COMPOSITES AAA6061

Composite materials are engineered from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct at the macroscopic or microscopic scale within the finished structure. Although composite materials had been known in various forms throughout the history of mankind, the history of modern composites probably began in 1937 when salesmen from the Owens Corning Fibreglass Company began to sell fibreglass to interested parties around the United States. Fibreglass had been made, almost by accident in 1930, when an engineer became intrigued by a fibre that was formed during the process of applying lettering to a glass milk bottle. Construction of aircraft structures, such as wings and fuselages, more commonly in homebuilt aircraft than commercial or military aircraft. 2024 alloy is somewhat stronger, but 6061 is more easily worked and remains resistant to corrosion even when the surface is abraded, which is not the case for 2024, which is usually used with a thin Alclad coating for corrosion resistance. Yacht construction, including small utility boats. Automotive parts, such as the chassis of the Audi A8.Flashlights.Aluminum cans for the packaging of food and beverages.

II. SILICON CARBIDE, ALUMINIUM OXIDE (AL2O3) &BORON NITRIDE

Silicon Carbide is the only chemical compound of carbon and silicon. It was originally produced by a high temperature electro-chemical reaction of sand and carbon. Silicon carbide is an excellent abrasive and has been produced and made into grinding wheels and other abrasive products for over one hundred years. Today the material has been developed into a high quality technical grade ceramic with very good mechanical properties. Alumina or aluminium oxide (Al_2O_3) in its various levels of purity is used more often than any other advanced ceramic material. Ceram Tec offers a wide range of material types with different property profiles that can be adjusted via a targeted matrix design. Boron nitride is a white solid material in the as produced hot pressed form. It is a low porosity solid. It is easily machined into complex shapes using standard carbide tooling. The material is anisotropic in its electrical and mechanical properties due to the platy hexagonal crystals and their orientation during the hot press consolidation.

III. LITERATURE SURVEY

G. B. Veeresh Kumar, C. S. P. Rao, N. Selvaraj , M. S. Bhagyashekar [1] In this paper we provide experimental result. It tensile strength, hardness and wear resistance Al6061-completed second And Al7075, Al2O3 composite. The composite prepared using liquid metal technique, in which, when 2-6. Age% of the particles from the base matrix is dispersed in every step 2. The thus-prepared mixture of the compound-Al7075 Al6061 thanks Al2O3 and shooting to prepare for the density, the hardness of the examples of the mechanical is judged to be carefully crafted eliminated with the tribological tests, and because on the ASTM standards Microstructural research. U S Ramakanth, VeeranjaneyuluKodeti, Dr. GVR Seshagiri Rao[2] presents Dynamic analysis was carried out for 6065 aluminium alloy plates (BP), ground plates (MP), spring plates (SP) and bare dough spring plate (SMBP) in different boundary conditions. The task of this project is to study the vibrational response of several

people plate boundary conditions with uncertain parameters at various frequencies. Basavarajappa S. and Chandramohan G [3] reports that Aluminium composite to be increasingly used in the transfer, aerospace, marine, vegetable and mineral processing industry due to the improved functional properties of strength, hardness and wear resistance. U. S. Ramakanth; Putti. Srinivasa Rao [4] presents the research examined the influence of sic and fly ash on the wear behaviour of Aluminium 7075/5 and weight percentage of hybrid complex. Aluminum alloy 7075 strengthened with sic-fly ash were examined. The effectiveness of integration of sic in the composite for obtaining wear reduction is investigated in this study. Uppada Rama Kanth, Putti Srinivasa Rao, MallarapuGopi Krishna [5] reports that Al-Zn compound supplement / fly ash / Thus, using a device to measure the vortex of casting, while stirring. The carrots are many thermal power plants Industrial waste fly ash, the main service. This article reports on the skill of the Microstructural and mechanical behaviour, zinc aluminium alloy, reinforced with fly ash and silicon carbide (SiC). Preparing composites reinforced flies and ash weight in each ranging from 0 to 10, with percentages. Such as particle size and 53% micro metre. Haitham Mohammed Ibrahim1, Dr.M.Gopi Krishna Mallarapu[6] explained the deformation of the paper, since they are composed of gifts of her womb, but the impact of these kinds of aluminium alloy A6061, strengthen their hybrid, Silicon carbide, (c) and fly ash. The newly formed A6061 / General / So hybrid composed of two different groups' hybrid materials.

A. Experimental Setup

The metal matrix composites samples are fabricated as shown in Fig 1.1 & 1.2 using stir casting method, thermal properties of AA 6061, AA 6061 + 5% Al2O3, AA 6061 + 5% BN, AA 6061 + 5% SiC metal matrix composites were studied by pin fin apparatus.

Fig 1.1 stir casting setup and fabricated samples

Table 1.1 shows the pin fin apparatus experimental study data of AA6061, AA 6061 T6 + 5% Al2O3, AA 6061 T6 + 5% SiC 7 & AA 6061 T6 + 5% BN MMC and Table 1.2 shows the Thermal conductivity, Heat transfer coefficient values of different composites.

Table 1.1 pin fin experimental setup data

MATERIAL	T1	T2	T3	T4	T5	TS
AA 6061 T6	59	58	54	53	52	55.2
AA 6061 T6 + 5% Al2O3	93	85	84	81	71	82.8
AA 6061 T6 + 5% SiC	81	80	70	76	69	75.2
AA 6061 T6 + 5% BN	96	89	84	79	78	85.2

Table 1.2 Thermal conductivity & Heat transfer coefficient of Composite MM

MATERIAL	Thermal conductivity	Heat transfer coefficient
AA 6061 T6	167	8.62
AA 6061 T6 + 5% SiC	179	9.2
AA 6061 T6 + 5% Al2O3	180	9.48
AA 6061 T6 + 5% BN	186	10.2

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B. Steady State Thermal Analysis of a Fin and a Chip

The fin is made of Aluminium MMC'S, while the chip is made of epoxy as shown in the Fig 1.2. Free convection boundary condition is imposed at the fin surface and the vertical sides of the chip with h_{AA6061} 8.62 W/m2-°C and T0 (25°C), while the chip's bottom surface is well insulated. A power of 15 W is generated in the chip. Let k_{chip} = 0.2 W/m-°C and $_{KAA\ 6061}$ = 1677 W/m-°C

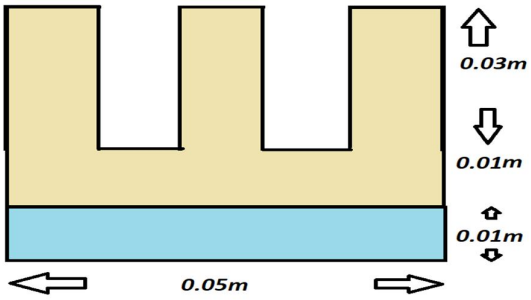

Fig 1.2 fin and chip

C. Finite Element Method for Thermal Analysis

By using finite element method to examine the performance of a straight fin used for cooling an electronic chip by determining the maximum operating temperature of the chip at the steady-state condition.

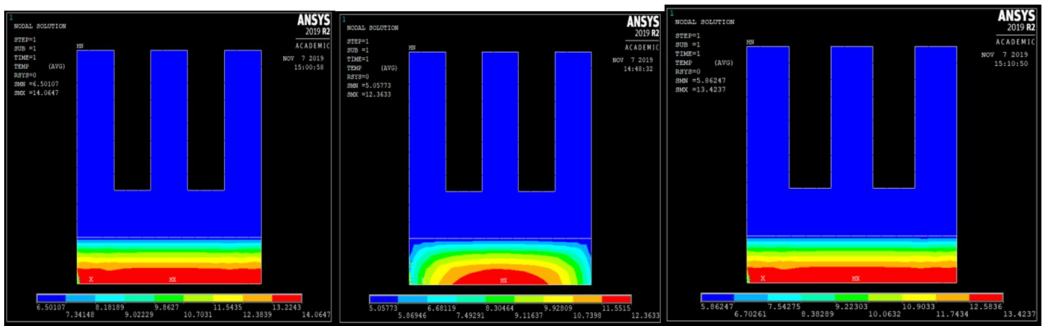

Fig 1.3Temperature distribution of AA 6061, 5% (SiC, Al2O3) Composite Material

The temperature contours indicate that the maximum temperature is located at the bottom surface of the chip, which is equal to 14.064°C as shown in Fig 1.3 and heat flux is shown in Table 1.3 for the AA 6061 T6.The temperature at the base is perfectly parabolic as shown in Fig 1.4 due to the symmetry in the problem. The above graph indicates that the maximum temperature at the bottom surface of the chip is 14.064°C. &13.424.

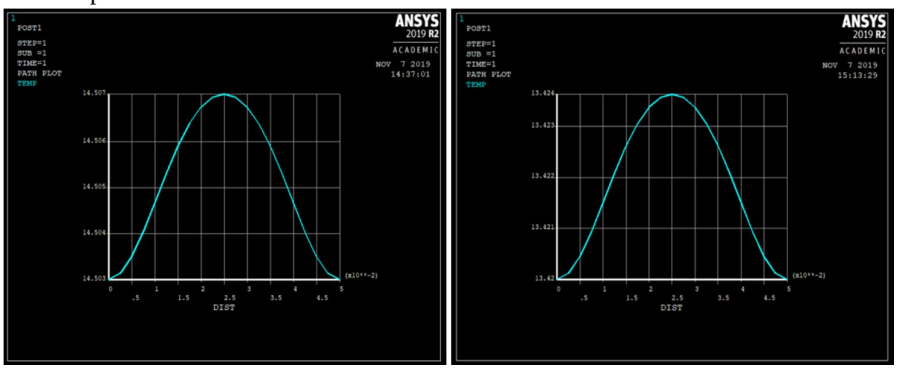

Fig 1.4channel temperature at the base of AA 6061 T6 + 5% SiC& BN Composite Material

Table 1.3 Temperature (Avg)&Heat Flux of MMCs

MATERIAL	Temperature (Avg)	Heat Flux
AA 6061 T6	14.064	585.789
AA 6061 T6 + 5% Al2O3	12.363	585.789
AA 6061 T6 + 5% SiC	13.423	585.076
AA 6061 T6 + 5% BN	14.506	585.789

D. Transient Thermal Analyses of Fin

For the fin shown in Figure 1.5, the case study is an unsteady state and aim is to determine the temperature distribution in the fin at 100 s if the initial temperature of the fin is 25°C. The total duration is 200 s and the time step is 2 s. The fin is made of AA 6061with the following properties: ρ = 2700 kg/m3, *k* = 167W/m-°C, and *Cp*= 8690 J/kg-°C. The bottom surface of the fin is maintained at 100°C, and the surface is subjected to free convection with *h* =8.92 W/m-°C and 25°C.

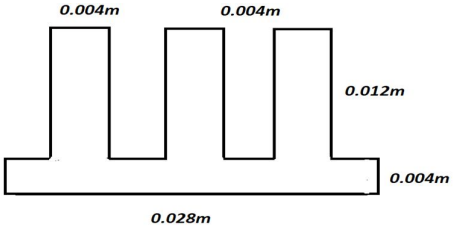

Figure 1.5 the case study of sketch

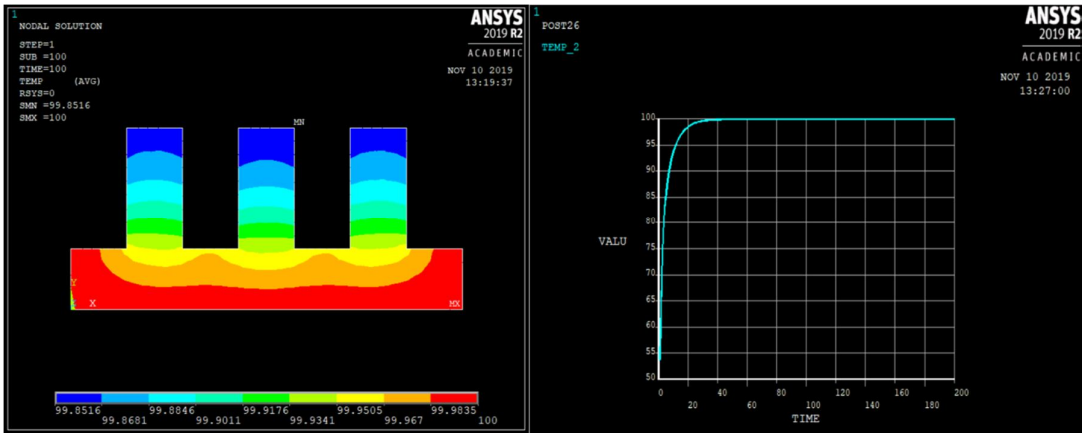

Fig 1.6temperature history at the centre of the fin's baseat 100 s&selected location

E. Results and Discussions

The stir casting was used for the fabrication of samples, the cast iron mould was used for the preparation of samples. The AA 6061 billets and SiC, Al203 and BN particles are purchased from vendors the samples are prepared in the inert gas medium to avoid the oxygen react with the molten metal during the casting process. The electric stirrer was used for getting the correct molten metal. In the pin fin apparatus experiment the thermals conductivity and film coefficient was determined with help of steady condition for the AA 6061, AA 6061 + 5 w.t % of Sic, AA 6061 + 5 w.t % of Al203, and AA 6061 + 5 w.t % of Boron Nitride samples. The thermal conductivity and film coefficient good for the AA 6061 + 5 w.t % of Boron Nitride sample compare to the other three materials shown in Fig 1.7.

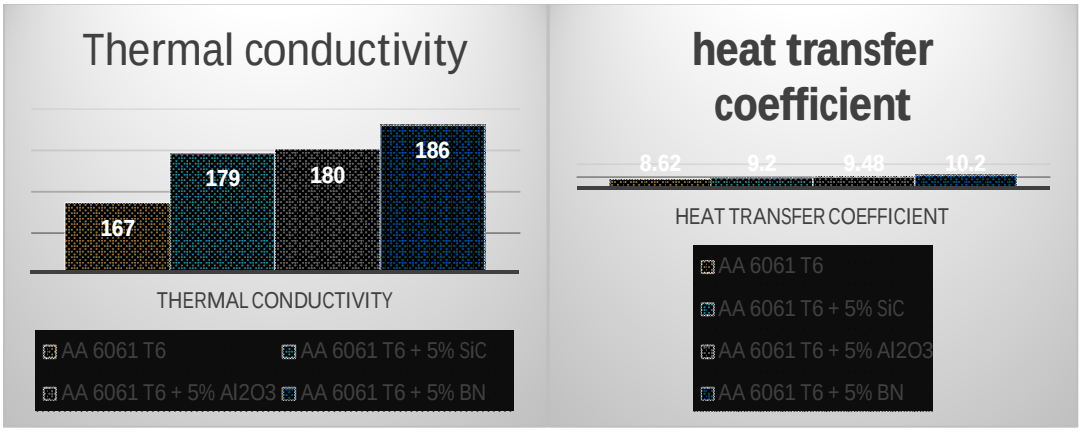

Fig 1.7 thermal conductivity and film coefficient of four MMCS

Finite Element Method for Thermal Analysis examine the performance of a straight fin used for cooling an electronic chip by determining the maximum operating temperature of the chip at the steady-state condition and transient thermal analysis of a fin made of AA6061was performed and results are shown in fig1.6.

IV. CONCLUSIONS

A. The different MMCS samples are fabricated using stir casting machine efficiently without getting the blowholes on the samples.

B. Successfully found the thermal properties of AA 6061, AA 6061 + 5 w.t % of Sic, AA 6061 + 5 w.t % of Al203, and AA 6061 + 5 w.t % of Boron Nitride metal matrix composites using pin fin apparatus

C. The temperature distribution of the around the chip was found for different materials of fin samples , AA 6061 + 5 w.t % of Boron Nitride sample given the good result in the unsteady state condition using ANSYS software.

D. The transient analysis was success and AA 6061 + 5 w.t % of Boron Nitride sample given the good result.

V. FUTURE SCOPE

A. A research is important for determination of thermal and electrical properties of different MMCS.

B. Experimental and analytical study was also need for comparing the results for getting accurate.

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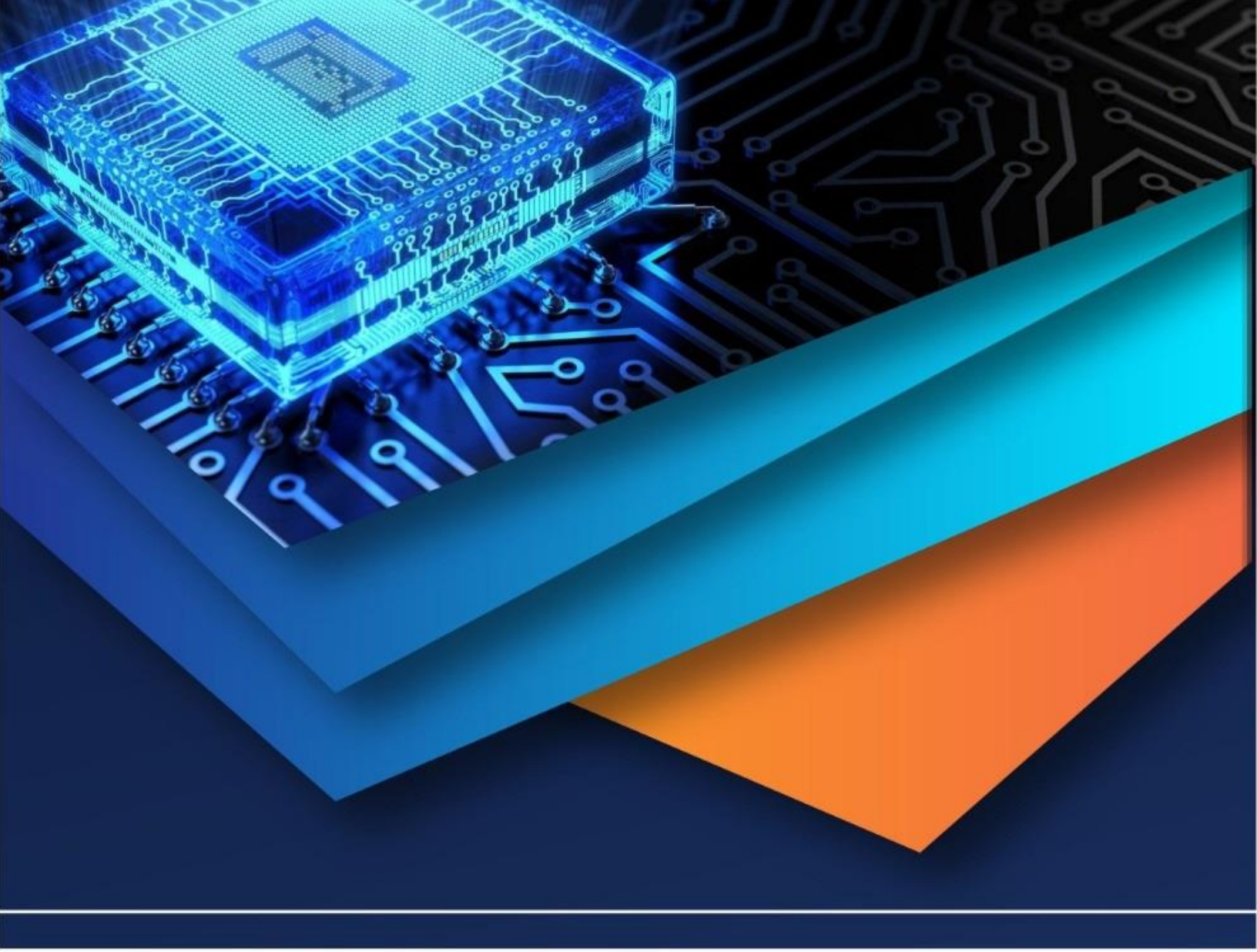

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