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Review on The effect of adding Ceramic Particles On the Properties of Aluminum alloysprepared byPM method

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Abstract:-

The evolution in material engineering is the result of recent research and studies in Determine the maximum values of the relationship between the microscopic structure and the different properties of the developed parts

Suitable for different industrial applications. And made the base metal composite material Aluminum is a major development in the field of engineering materials, as it has given more advanced properties Conventional aluminum alloys. The process of modernization is constantly evolving The use of inexpensive stiffeners is becoming increasingly widespread Especially in the field of industry. The compound material is aluminum-based, reinforced in minutes or Silicon Carbide (SiC) bristles are more popular and used due to the possibility The uniform distribution of minutes within the base material and these substances give important properties such as Good wear resistance, wear, high toughness, hardness and durability at low density when compared With base material. One of the most prominent applications of this type in space ships and air navigation Engineering and medical applications (2000, Russell).

2.1 Aluminum alloy basics: -

In the American naming system for aluminum alloys there are basic or fundamental alloying elements and often combine with other elements and refer to these compounds with a series of special preparations and listed in Table 1-1, as aluminum alloys are generally divided into the following two classes:

1- Wrought Aluminum Alloys.

2- Cast Aluminum Alloys.

The classification system for aluminum alloys is followed by a four-order numbering system as the number indicates the first to the first rank and the group and the second rank include determining the type of alloy or impurities, while the other salaries refer to the appointment of the different aluminum alloys in the group. As for the best method used to determine the treatment to which the alloy is subjected, it is by adding one letter after the alloy code followed by some numeric ranks which are: -

F: manufactured case.

H: hardened by formation + partial fermentation (H1 …… ..H3).

series Number	The alloy type

O: fermentation and

recrystallization state.

T: Used for hardened alloys, soluble treatment and aging to stable state ((T1 ... T9).

The formed alloys can be classified into:

(Table 1-1 shows the classification of aluminum alloys) D. Apelian, 2009))

1XX.X	99.0% Al
2XX.X	Al-Cu
3XX.X	Al+Si&Mg or Al+Si&Cu or Al+Si&Mg&Cu
4XX.X	Al-Si
5XX.X	Al-Mg
7XX.X	Al-Zn
8XX.X	Al-Sn

1- Non-heat-resistant alloys that obtain high resistance to either hardening Emotional or solid solution treatment (D. Apelian, 2009)).

2- The heat-treatable alloys that can obtain a higher resistance to hardness The American Association has proposed a new naming system for the base compound material Of aluminum as the name consists of (base phase / abbreviated name of stiffening / volumetric fracture or Percentage with the phase of the stiffeners form (for example AA6061 alloy reinforced by Pala Lumina A fractional volume fraction of 22% is indicated by this designation AA6061 (P \ Al2O3 \), (Granet, 1980).

1- 3 Aluminum Alloy Applications:

Aluminum and its alloys represent the most important engineering materials of low density that have their uses industrial use The use of these materials has increased dramatically at present, as needed necessary to use low-density materials to suit technological advances and keep up with it. Aluminum is the most common ingredient in mineral composite material (MMCs), as Aluminum alloys are distinguished by their resistance to corrosion, high thermal and electrical conductivity, and their portability the relay should be deposited in addition to its low density and relatively low cost.And he was interested in composite materials based on aluminum AMCs widely in the 1920s and was used in many fields including the automotive industry and sports equipment and aircraft structures and electronics packaging, which is often strengthened by ceramic minutes such as alumina, silicon carbide, carbon and also can be used as power carbide Wen B4C and BN boron and SiO2 silica. Among the many different applications is the rotating part of the German train spoiler ICE2, ICE1 which was developed by (KonerBremse AG) and made of AlSi7Mg + SiCP (Dural can) compared to the regular parts made of (piece / kg120) cast iron Therefore, the manufacture of a rotating part of AMCs with a weight of 76kg can be considered unique in the field of weight reduction (Meyers, 1999). In recent years, the prices of minerals and their alloys used in industry have risen, so resorting to extracting metals from scrap, especially aluminum, it is known that aluminum production globally with international specifications and by 40% of global production is obtained from scrap and with less energy and is equivalent to almost 90% of the energy needed to produce Aluminum is one of its raw materials. The problem of aluminum alloys is the low melting point, which makes them more vulnerable to deformations due to pressure when exposed to heat. This situation can be addressed by placing these parts exposed to the pressure inside an oven and we follow them gradually and did not prevent the low melting point of the aluminum alloys from being used in the manufacture of missiles as well as their use in building the combustion chamber as the gases can reach C 3 3000 Wikipedia (aluminum alloys, 2008).

Figure 1-2 shows piston internal combustion presses (Wikipedia Aluminum Alloy, 2008).

The presence of a silicon element is of great importance in aluminum alloys, which improves its properties by reducing the coefficient of thermal expansion and improving other properties, including resistance to wear, plumbing, corrosion and operation, and this led to their use in parts subject to high friction such as pistons and cylinder heads (2004Warmuzek), as In Figure (1-3).

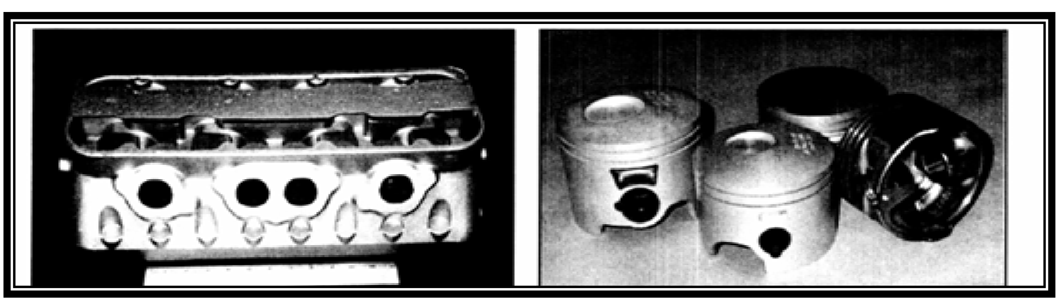

Figure 3-1 shows pistons and hoods made using the traditional sand plumbing method.(A.Lee, 2003)

Modern technologies require the use of alloys of high specifications that can not be obtained at The use of traditional alloys, ceramic and polymeric materials, as each application has requirements Especially must be provided, therefore, the use of the compound material was used and developed to cope with itTechnological progress is taking place. There is a set of important properties and tests that he studied Previous researchers can be presented in the following paragraphs: -

1- Study the microscopic structure: -

(Hasan, 2005): He studied the microstructure and the effect of heat treatment on developmentMicroscopic structure when the hardness is high and the dispersion is dispersed through a base alloy Aluminum has been used as an alloy Al-10Zn-1Cu-2.3Mg-0.18Zr)) and add to it a reinforcing substance Ceramics are SiC ratios (7.8%, 11.5%) and note that when the hardener increases, it increases the mechanical properties of the composite material are improved, and the effect of heat treatment is studied as it becomes the compound material is more uniform and uniform after thermal treatment, thus increasing the hardness and useXRD examination to analyze the microstructure of the structure.

(Yoon and his group, 2007): The researcher was interested in studying the mechanical properties of rapid freezing the reinforcement in the Al-20% Si alloy where the granular size of the powder ranges between m µ (145-106). The isotropic angular rotation method was used in the powder trust processSilicon stiffeners have been found to improve the tensile strength of the alloy from MPa (280-280) Without the loss of the coated and the resulting strain amount is above 30% due to the extrusion pressure during the process of isometric angular rotation of pressure and also found that silicon granules have a smaller size from µ10 m in the case of powder to 5 mµ and 3 m in the case of isometric angular rotation (KARAkULAK AND, ZEREN2008): Study the effect of adding copper to the Al-Si alloy In a ratio ranging between 2-0.05 (Cu) and the effect of the addition on the alloy's hardness and its mechanical properties Conduct the heat treatment of Al-Si-Cu alloy with a temperature of 500 ° C for a period of 7 h and run it Annealed at 190 ° C for 15 hr and all operations were performed in a heatproof furnace Increasing the copper percentage (2% -5%) increases the hardness from 55 HB to 115 HB without Heat treatment and with it, but increased hardness after heat treatment is more effective when Copper content is high.

(Mohamed and his group,2019):the present work was undertaken with the aim of studying the microstructural changes aswell as variations in the tensile properties of 413.0 alloy. The ultimate tensile strength (UTS),elastic limit (YS) and elongation to fracture (%El) resulting from the addition of alloying ele-ments –

strontium (Sr), magnesium (Mg), copper (Cu), silver (Ag), nickel (Ni), zinc (Zn), cerium(Ce) and lanthanum (La) to the base alloy, and heat treatment were measured. Furthermore,the effect of the addition of phosphorus (P) as well as heat treatment on the microstructureand properties of the base alloy 413.0 modified with Sr was studied from the point of viewof the interaction between phosphorus and strontium during the solidification process.

2- Study of improving thermal conductivity: -

(Sastry and his group, 2004:) One of the things I care about most is the effect of porosity on thermal conductivity Thermal diffusion under cold pressure and alloy pressure (Al-17Si-5Fe-3.5Cu-1.1Zr) it has been found that the thermal conductivity and the thermal diffusion depend on the porosity, so the conductivity decreases The thermal increase of the porosity automatically, and it was also found that at cold pressure, the pores are distributed irregularly on the surface, so the pores are joined together to form pockets that are responsible for the decrease in the thermal conductivity by increasing the pores.

(Abdullah and his group, 2008): a description and preparation of a compound-based substance (Al- 7Si-0.3Fe) He added to her a booster material: SiC at a rate of (5% - 15%) and used XRD X-ray Analysis to obtain and analyze the existing phases, and from the results obtained, it is carbideSilicon and its increase reduces the coefficient of thermal conductivity, which becomes for an Al-Si alloy equal to (194 kw / m) for Al-Si / 5% SiCp (103w / mk) and for P Al-Si / 15% SiC (95w / mk). The compound material in which the booster material is SiC 15%, the porosity level is high as carbide silicon is a ceramic material, the thermal conductivity factor has little and this is another factor reducing the thermal conductivity of the Al-Si / 15% SiC_p alloy. A Rockwell hardness test was conducted and it was found that increasing the booster It increases the hardness as the hardness of Al-Si is equal to ((43.5HRB) and the hardness of the alloy Al-Si / 5% SiCP equals (52.3 HRB) and the highest hardness at the highest reinforcement ratio SiCP Al-Si / 15% is equal to (73.5HRB), and through Microscopic examination shows that fine particles of small granular size lead to higher hardness.

(Vargatd,2009): researched the Al100-x-Six alloy (x = 12,20,40). And prepared by the method of rapid freezing and added some elements to it as follows: -3.97% Mg-0.06% Mn-0.04% Fe-0.7% Cu-0.21% Cr-0.012% Zn-0.08% Ni- 0.05% Ti and relied on X-Ray, SEM, X-ray patterns and optical microscope thermal and expansion analysis. Through experimental work it was found to increase the rate of cooling of the alloy

(Al-12Si) leads to an increase in the solubility of silicon in the solid solution, as well as proven experiments

Increasing the percentage of silicon leads to a decrease in the coefficient of thermal expansion.

2- Study the wear and tear behavior:

Now a days, aluminium-based metal matrix composites (Al MMCs) are used in making of piston, connecting rod, contactors, where sliding is an important factor [26]. Excessive wear of the mating components sometimes leads to catastrophic failures [27]. So study of wear properties of Al MMCs has become the need of time. Wear tests are generally conducted on ball/pin wear tester, schematic diagram as represented in Figure 3. Wear properties of many MMCs having continuous and discontinuous reinforcements like Al_2O_3, MnO_2, SiC, graphite, mica, glass, graphite and others have been reported [28, 29, 30].(Rashed and his group, 1993): Prepare a metallic base material and use the Al-20% Si alloy and added to it a ceramic material for the reinforcement is (Si3N4, 30% SiC, α-Al2O3 (WC, sizes) Different granularity. Prepare the ingot in a powder technology with a hot pressure and one-way(500Mpa, between improved hardness and mechanical properties such as wear and tear resistance) tests on the reinforced alloy and the best results obtained are high hardness and wear resistance Excellent for reinforced alloy with (30% SiC) and granular size ranging between µm (100-250)compared to the base material.

(Kady and his group, 2003): Show the effect of wear behavior of an alloy (Al-16.47Si-4.29Cu) prepared

By pressing plumbing method and again by spiral plumbing at high temperatures.One of the results was that the largest wear resistance occurs in the plumbing samplesSqueeze casting while whirlpool plumbing increases the agglomeration on the crystalline boundaries and thus reduces the placement susceptibility. It was found that the increase in the ratio of reinforcing materials increases wear resistance, because the increase in the SiC ratio leads to an increase in the hardened minutes that bear the load, and thus This researcher has found that the wear and tear at high temperatures (° C250,200,150 °) is affected by the ratio of added stiffness and its applications include manufacturing motor vehicles and mechanical equipment.

(SaadHameed and his group, 2007): They were interested in studying the effect of adding graphite on the wear resistance of an alloyAluminum-silicon, as the base ingot was prepared by a plumbing method by mixing and adding graphite to it (5.5%) using the vortex Technique Stirring technique, and then the samples were prepared to test the sliding wear and tear, and it was found that the wear rate increases in the case of an increased load and a distance Slip and surface roughness, as well as between the researcher, the wear resistance of the composite material is higher than that of the base material.

(Muhammad Saeed and SudairMwaffaq 2009): They were able to prepare a composite material based on aluminum 99.9% purity with SiC (α) booster in powder metallurgy method. Has been added The stiffening material is in different proportions (7.5% -10% -15%) and has a particle size of (mμ125) and the end The main is to study the properties of a compound (wear and tear rate) by examining Brinell hardness It has been found that the hardness increases with the strengthening of silicon carbide during wear and tear effect of projected load on wear rate of carbide and non-reinforced samples using loads (5, 10, 15) Newton for twenty minutes of silicon. And the results showed that the increase in the projected loadThe rate of wear increases, the wear resistance decreases, and the smallest wear resistance of samples not SiC-fortifiedAlso, as the slipping speed increases, the wear rate increases for the SiC-strengthened samples(Dr. AqeelZahir 2008): Explain the effect of adding iron and lead to the alloy (Al-13% Si) On phases, friction and wear characteristics during sliding of this alloy under slipping conditionsDry on a carbon steel disc under the influence of a wide range of different loading pressures MPa (37.4-187.3) as shown by an X-ray examination. The phases present in the Al-13% Si alloy are (phase-phase and primary silicon), either as an alloy (Al-13% Si). -2% Fe-2% Pb) It was found that there are three phases, which are lead phase and the Uticake phase and the fragile $Fe_2Si_2Al_6$ phase, which is the reason for the increase in wear rate due to its fragility when increasing the loading pressure and found that The coefficient of friction of the alloy after adding iron and lead increases with the increase of the projected load. It also shows the presence of wear mechanisms that occur when adding iron and lead. Mineral, they occur as a result of the loading pressure having the ability to completely break down the agaids formed on the exposed surface of the wear, as wear mechanisms depend on the phases of the alloy floor and its hardness in addition to the loading pressure.

(Zikra Mahdi, 2009): adding glass by (5% -3% -1%) for pure aluminum using Vortex technology (mechanical stirring) and the results of mechanical properties have shown an increased resistance Compression, yield strength and hardness resistance by increasing the reinforcement material (increasing the proportion of glass) either Wear tests. I used the screw method on the disk with a load of (20N) and quickly Constant slipping (2.7mm / sec). Tests have shown a decrease in wear rate, with an increase in the material percentage Relay.

Dey and his group, 2009): his study summarizes the wear and tear mechanisms at low loads for Al-18.5Si alloy.) The alloy is prepared using a sand plumbing method at high sliding cycles, and has been used. The way of the nail on the disc to test the wear and tear and use a load of (5 N and a sliding speed (0.05mm / sec), which led to the breakage of silicon granules into fine granules where they work These granules, as an oil, reduce friction forces and thus lead to reduced wear and tear, and improve Wear resistance at low loads.

Santos (and his group, 2006): I am interested in the corrosion behavior, as his study of Al-26.64% Si-5.2% Cu alloy () produced by the method of spray formation and I used the spectrum blocking method. Electrochemical in acid solution (PH = 3.3), neutral solution (Ph = 7) and finally solution Base (PH = 11). The results showed that the acid electrolyte causes a local attack Severe disability decreases with the time of immersion inside the solution, either in the neutral medium an attack occursOn an area less than a piece, and in the base medium, corrosion products are formed within the first hour From immersion, the obstruction increases, but the thickness of the surface layer leads to the growth of cracks that expose the surface to decreased disability over this period. This behavior studied.

(Najm and Abdel-Amir Student, 2008): Interested in studying the wear and tear behavior of Al-20% Si alloy.

Pure aluminum and 20% pure silicon were added, and the casting process was performed Cylindrical and used (Pin on Disc) to test the wear and tear, and another alloy was prepared Of Al- 20% Si)) and some elements were added (0.03% Ti) and (0.09% B) added Walk on Sr, sodium, and phosphorous in the form of salts for the purpose of knowing the effect of each of these The elements in the modification of the shape of the primary silicon minute phase and the yottic phase, and wear test Using a load of 12.5N and a duration of 30 minutes, it was found that the wear rate decreased and the wear resistance increased When increasing the percentage of silicon components and casting elements, as well as the alloy hardness containing Silicon and casting elements are high up to (94-135 HB) higher than the usual alloy Al- 20% Si, whose hardness is about (75-76 HB), and a rapid cooling of the alloy has been performed. The container contains alloying elements by extinguishing with snow from (150 ° C) and has obtained a microscopic structure Very fine for granular granules of the size (120µm), which is why they increase hardness Ingot.

Anandkumar (and his group, 2007): attended a compound of Al-Si and their effect was studied A coating layer on the compound material using the laser cladding method. The powder mixture is Al-12% Si) with an amount of 30% SiC. One of the important things that was included in the study are the standard factors on the microscopic composition and wear resistance, as indicated by Examination of the microstructure. The appearance of the α-Al phase and the Al-Si α Uticec phase. Among other results, the initialization of the coating at the highest specific energy (58MJ / m3) represents hardness (250HV), wear rate 1.7 * 10-4 g / sec). Whereas when the specific energy is 26 MJ / m3)) it has a hardness of 120 HV) and a wear rate of g / sec) (0.43 * 10-4 where a load of 20N) is used to check the hardness and it has been shown that the hardness of the coating layer is It is higher than the base alloy, as SiC minutes are concentrated at the bottom of the coating layer when temperatures are low. The lack of similarity or difference between silicon minutes and a hand of silicon and Al4SiC4 is not important for the hardness of the material, but this improves wear resistance, and as a result, the Si, Al4SiC4 phase increases. Hardness of the material by hardened dispersion. Likewise, it is important to rely on the main interaction between silicon and molten aluminum.

Singla (and his group, 2009): attended a compound material based on aluminum (98.41%). And he added to her a material for strengthening the car is in the hand of the silicon in different proportions (5%, 10%, 15%, 20%, 25%, 30%). The researcher studied the effect of the strengthening ratio on the hardness of the foundation and found that the strengthening rate at 25% SiC increases the hardness of the base material because increasing these minutes gives a high resistance For soft deformation the hardness increases by 45.5 HB as well as the shock resistance (36 N-m) becomes at 25% SiC and when we get the best hardness and shock resistance, I also used a method to distribute Granules homogeneously inside the base material where the method of manual mixing was adopted in a process Plumbing of the material and obtained the best specifications for the presence of the reinforcement material.

(Adnan Ibrahim Al-Jarr Jerry, 2010): Aluminum alloys are considered to be second-most important alloys

Steel, but aluminum extraction is expensive and needs energy, so the researcher studied the process of extracting aluminum from scrap in Iraq, where he took advantage of many of the scrap available in Iraq and studied the hardness and microscopic structure of the products after the smelting and casting process of the chosen alloys as I use the piston alloy of the engines which are within the categories of cast aluminum alloy 3xx.x as for the alloy of the hood is located Within rating Classification 4xx.x Finally, I used the aluminum alloy with the presence of 1% of the alloying elements, such as silicon and magnesium, which fall within the category 1xx.x. After the smelting process of the alloys, casting with special molds, and performing grinding and polishing operations with a 0.5-millimeter HF solution plus distilled water, then the models were photographed and the microstructure of the models was studied and the Vickers hardness scale (HV) was found, where it was found that the highest hardness we get is when mixing different proportions of the three alloys 20 % Of the alloy is 3xx.x, 40% of the 4xx.x alloy, and 20% of the 1xx.x alloy, where the hardness reaches 56.358 HV while the hardness of the piston alloy 51.941 HV and the hardness of the hood 62.782HV and the pure aluminum hardness 36.261 HV So the result must choose the appropriate mixing ratios of the alloys Scraps for obtaining alloys with properties suitable for engineering applications.

4- Studying the effect of heat treatment:

(Abudlwahab, 2008): Research on the Mechanical Properties of Al-2.1Si-0.7Fe Alloy, It has Mn manganese with a different ratio 0.1 - 0.5 (%) and used the heat treatment by heating to 490 ° C in an electric oven and then quickly quenching with water the samples damped were freed with a degree of 200 C for 6 hr) before it cooled to the air. Manganese up to 0.4% increases UTS and hardness (HRB), but it reduces shock resistance and is believed to be caused by the interstitial phases Al6 (Mn, Fe) & Al-Si-Fe-Mn) α that impede the movement of dislocations and then increase The tensile strength and hardness of Rockwell. As for the reduced impact resistance, it is due to a real interaction between erosions and sediments, so you need high shear forces, so they decrease. P shock but the shock of the properties of samples solidified Baltotaiq better than the basis for casted (explained these results in the plans for each of the alloy samples solidified Baltotaiq.

SWAMY (2010): Interested in studying the effect of heat treatment on resistance and wear and tear behavior

For Al6061-SiC alloy) as it added silicon carbide in different proportions (2% - 4% -6% -8% -10%) And the granular size (10-20 m m) where heat treatment was carried out by heating to C530 °,For a period of (1hr) and rapid quenching in different media (with water, air, snow). And aging at a degree of C175 ° for a period of 8hr)) Air suppression, also the wear test was carried out for the Al6061-10% SiC alloy)) and a fixed time of 15 min was used and different loads 5N, 10N, 15N, 20N)) and it was found that the wear resistance increases By increasing the SiCp components and the thermal treatment improves the wear and tear behavior of the Al6061 alloy (Al6061-SiCp). All of these previous results were illustrated with diagrams illustrating the effect of adding silicon carbide on hardness, tensile strength, and wear resistance without or with thermal treatment.

(Wahid &Abd 2009): Prescribed metallic composite material (aluminum) and ceramic reinforcement materials(Silicon carbide and alumina) using mono pressing in powders and drying and sintering at a degree of 500 ° C. It was found that the wear resistance is as great as possible when mixing ratio 12.5wt% SiC), 12.5wt% Al2O3) where the density is (2.5479 g / cm3) And the wear test was done below The effect of two conditions are load change and linear velocity change.

Summary

Present industrial developments are associated with materials having advantageous physical, mechanical andwear characteristics that can achieve technological needs. Aluminium and its composites are best suited materials as have better properties than unreinforced materials. Beneficial properties with reduced prices have enlarged their applications. Al MMCs are used in defence, aerospace, automotive, aviation, thermal management areas in engine pistons, cylinders barrel, connection rods, elements of vehicles braking systems because of their unique properties of high hardness, high strength, high stiffness, high wear, abrasion and corrosion resistance.

Reference :

1. *Mohamed Hassan Abdelaziza, Agnes M. Samuela, Herbert W. Dotyb, Salvador Valtierrac, Fawzy H. Samuela,∗,*" Effect of additives on the microstructure and tensile properties of Al–Si alloys", journal of materials research and technology ,2019,**8(2)**:2255–2268.
2. Abdulwahab - M. " Studies of the mechanical properties of Age- hardened Al-Si-Fe-Mn alloy", Australian Journal of Basic and Applied sciences ,2(4):839-843 ,2008.
3. Anandkumar - R.Anandkumar , A.Almeida , R. Colaco, R.Vilar , V.Ocelik, J.th.M.DeHosson ," Microstructure and Wear studies of Laser clad Al- Si\SiC$_p$composite coatings ", surface & coatings Technology 201 ,2007.
4. Abdul Ameer-Dr.Najem Abdul Ameer , Eng. Talib Abdul AmeerJasim " study the effect of Grain Refinement and modification on the Dry Sliding wear Behaviour of Hypereutectic Al-Si Alloys" ,the Iraqi Journal for
5. Mechanical and material engineering , Special ssue(A), 2008.
6. Abdullah - Yusof Abdullah ,Abdul RazakDaud ,Mohdb.Harun ,Roslindashamsudin, " Characterization of Al-Si alloymatrix reinforced with fine SiC composite", JNUCL& Rel. TECH., Vol:5,No.2,p(19-5) ,2008
7. Apelian -D.Apelian" Aluminum cast Alloys ",Aworldwide Report 2009.
8. Angelo -R.Subramanion and P.C. Angelo ," Powder Metallurgy", 2009.
9. Ashby -Michael Ashby ,Hugh Shercliff and David Cebon "Materials Eng.Science ,Processing and Design
10. ",University of Cambridge U,K.pp(228-241).
11. AST|M -Annual Book of ASTM Standards, part 10,G_3 ,1974.
12. ASM -International:,"Alloying",Edited by J.L.Walter and Others,Carnes Publication Service ,Inc.1988.
13. Ajappai -S.B.Ajappa,G.Chandramohani,R.Subramonlan Materials Science-poland,vol.24,No.2/1 ,2006.
14. Baker - Ian Baker , Daniel Cullen ,Michael Gwaze , Annika Grosse " AMicrostructural study of wear Mech--anisms in onventionallygrined and Nanocrystalline Aluminum- Silicon Alloys", The city college Of New York,NY 10031, 2009.

15. Boltn -W.Bolton,"Engineering Materials Technology ",3rd ed ,1998.

16. Bronsveld - P.M.Bronsveld , P.Bruinsma and J.th.DeHosson "Microstructural analysis of hot isostatically Pressed (Al-SiC)" , university of Groningen , Alsem ,Billition Research B.V.P.O.Box 38, 6800 LH Arnhem ,1991.

17. Colm -MC .Colm&N.J.Clark,"Forming ,Shaping and Working of High Performance",Blackie& Son ,1988.

18. CANDAN - Ercan CANDAN " Effect of Alloying Elements to aluminum on the wettability of Al \ SiC system ", Turkish J.Eng. Env, Sci. 26,ZonguldakKaraelmesUniversty ,2002.

19. Chawla - NikhileshChawla and krishank.Chawla ," Metal Matrix Composites " ,2006.

20. Callister -W.D.Callister,Ir:"Materials Science and Engineering An Introduction ",5th,John wiley& sons ,2000.

21. Dechang -JiaDechang,ZhouYu,Lei ,Tingquan ,J.Rara Metals ,17 (1998),98.

22. Dey -S.K.Dey, T.A.Perry ,A.T.Alpas " Micromechanisms of low load wear in an Al- 18.5%Si alloy", Elsevier B.V.All rights reserved ,2009.

23. Das -S.Das " Development of Aluminum alloy composites for Engineering applications " Trans .Indian Inst. Met , vol:57, No.4 ,pp((325-334) ,2004.

24. Dowon -Gordon Dowon " Powder Metallurgy the process and its Products",AdamHilger,Bristol andNewYork ,1990.

25. Dorre -E.Dorre,H.Hubner,"alumina processing ,properties,and applications ", springer – velarg,Berlin, Heidelberg,New Yourk,Tokyo,1984.

26. Egre -T.S.Egre"Wear Characteristic of metals ", Tribology Int.,October ,(1976).

27. **EFAZAKAS** - B.VARGA EFAZAKAS L.K.VARGA ," REPARATION AND STRUCTURAL CHARACTEIZA TION OF RAPIDLY SOLIDIFIED Al-Si Alloys ", Bulletin of the Transilvanianiversity of Bvasov, Vol:2 , seriesI ,2009.

28. Eidhed- WitthayaEidhed and NattaponViboonpun " Effect of Solution timeon Microstructure and Hardness of Al-Si-Cu- Ni alloy",Kingongkut's Institute of Technology North Bangkok ,2003 .

29. Fontana -Fontana,M.G."Corrosion Engineering",3rd ed .,McGraw- Hill 1986.

30. Granet -I.Granet,P.E:" Modern Materials Science ",Reston publishing Co ,1980.

31. Groover -Mikell P.Groover,"Fundamentals of Modrern Manufacturing",Johwiley&sons ,Inc.(1996).pp(393-416)

32. Gasem -ZuhairM.Gasem and Amro M. Al-Qutub " Corrosionbehavior of powder Metallurgy Aluminum Alloy 6061\Al_2O_3 ,Metal Matrix Composites" , The 6th Saudi Engineering Conference ,K FUPM, Dhahran ,2002.

33. Hossford -WillamF.Hossford"MechanicalBehaviour of Materials"university of Michigan ,2005.

34. Hasan - S.T.Hasan " effect of heat treatment on Interfacial strengthing mechanisms of second phase Particulate Reinforced Aluminum Alloy", p(24- 26.5), HradecnadMoravici ,2005.

35. HaizhiYe -HaizhiYe" An Overview of the Development of Al-Si alloy Based Material for Engine Applications ", ASM International, Journal of Materials Engineering and Performance,Vol:12 ,2003.

36. Higgins -R.A.Higgins" Engineering Metallurgy", part 1 ,Applied physical Metallurgy 4thedition,London ,1973.

37. Jacques -Michel Jacques and Dr. Martin P. Schmidt" Corrosion of Aluminum " ,2004.

38. Kady -E.Y.El- Kady , F.Mahmoud , and G. Nassef ," Wear behavior of Squeeze cast Al-SiC_p composites at room and elevated temperature ", Faculty of Engineering Alexandria University ,Egypt,vol:42 ,No.4, pp(357-369) ,2003.

39. Kingery -Kingery,H.K.Bowen,D.R.Uhlmann,"Introduction to Ceramic Materials",2nd ,Edition ,Johnwiley and sons ,(1976).

40. Lansdown -A.R.Lansdown andA.L.Price " Materials to Resist Wear",(1986).

41. Koehring -R.P.Koehring ,in powder Metallurgy ,ed .John wulff(Cleveland: American Society for Metals, 1942,P.278.

42. Laha-T.Laha ,S.Kuchibhatla , S.Seal , W.Li , A.Agarwal ,"Interfacial phenomena in thermally sprayed Multiwalled carbon nanotube reinforced rights 2007. aluminumnanocomposite ", published by Elsevier Ltd.All reserved ,2007.

43. Lee -Jonathan A . Lee " Cast Aluminum Alloy for High Temperature Applications" ,132nd TMS Annual Meeting & Exhibition San Diego Convention Center , San Diego ,C A, 2003.

44. Massalski-T.B.Massalski,H.Okamoto , P.R.Subramanian,andL.Kacprzak,OH ,1990.

45. Merati -A.Merati," Astudy of Nucleation and Fatigue behaivour of an Aerospace Aluminum Alloy 2924-T_3 ".International J.of Fatigue Vol.27 ,2005,pp.33-44.

46. Meyers -M.A.Meyers,K.K.Chawla ," Mechanical Behavior of Materials" prentice –Hall,Inc New Jersey ,(1999).

47. Martin -John Martin " Material of Engineering ",3rd edition WOODHEAD publishing limited Cambridge England ,2006.

48. kanorov -S.P Nikanorov, M.P.Volkov,V.N.Gurin , Yu.A . Burenkov ,L.I. Derkachenko , B.K. Kardashev , L.I.Regel ,W.R. Wilcox "Structral and mechanical Properties of Al-Si alloys obtained by fast cooling Of alevitated melt " ,Elsevier B.v.All rights reserved ,2004.
49. Pai -B.C.Pai,K.L.Prabhakar and P.K.Rohatg ,Mat.Sic and Engineering,24(1976),p.31-44.
50. Park - W.Li, S.J.Park, P.Suri , A.Antonyraj and R.M.German " Investigation on die wear behaviour during compaction of aluminum matrix composite powders ", Orignal research paper , vol:0 ,No:0 ,2009.
51. Rajnovic-D.Rajnovic ,L.Sidjanin " Characterization of Microstructrue in commercial Al-Si piston alloy", University of Novisad , 2007.
52. Russell -A.M.Russell, L.Scottchumbley and Yun TinaJ.AdvanceEng.Mat.
53. Sarkar -A.D.Sarkar,"Wear of Metals",pergamum press ,(1976).
54. Srivastava- C.M.Srivastava,"Recent advances in materials research",Indian institute of technology ,Bombay (1984).
55. Somiya - ShigeynkiSomiya "Advances Technical Ceramics",Acadmic press ,1984.
56. Shankar -S.Shankar,Astudy of Interface Reaction Mechanism Between Molten Alumium and ferrous Die Materials,Ph.D.Worcester polytechnic Institute (2000).
57. Shreir - L.L.Shreir, and G.T.Bu rstein,R.A.Jarman,"Corrosion", vo.2 corrosion control,3rd ,2000.
58. Singla -ManojSingla ,D.DeepakDwived , Lakhvir Singh , Vikaschawla " evelopment of Aluminium Based Silicon Carbide particulate Metal Matrix Composite",Journal of Minerals & Materials characterization &Engineering, Vol:8, No.6, pp.(455- 467) ,2009.
59. Santos -H.O. Santos ,C. T.Kunioshi ,J. L. Rossi , I. Costa " The Corrosion Behaviour of a Hypereutectic Al-Si Alloy Obtained by Spray forming in Acid , Neutral Alkaline
60. Solutions ", Material s Science forum vols . 530 – 531 ,pp.(126-131) ,2006.
61. SINHA - ANIL KUMAR SINHA " Powder Metallurgy " ,1995.
62. SWAMY -N.R. PRABHU SWAMY , C.S. RAMESH and TCHANDRASHEKAR " Effect of heat treatment on Strength and abrasive wear behavior of Al 6061-SiC_p composites ", Bull. Mater .sci , Vol:33 ,No.1,pp.(49-54) , Indian Academy of sciences ,2010.
63. Sastry - K.Y.Sastry, L.Froyen ,J.Vleuges, E.H.Bentefour , and C.Glorieux, " Effect of Porosity on thermal Conductivity Al-Si-Fe. -X Alloy powder Compacts" , International Journal of thermophysics,vol:25,No.5 ,2004.
64. Trethewey -K.R.Trethewey"Corrosion for Science and Engineering ",Longtion Group limited ,1996.

65. VADIM -VadimS.ZolotorevskyNikolalA.BelovMichael V.Glazoff,"Casting Aluminum Alloys" ,2007.

66. Watkins -K.G.Watkins , M.A.Mc Mahon, W.M.Steen ," Microstructure and Corrosion Properties of Laser Surface Processed aluminum alloys : areview ", Department of Mechanical Engineering, University of Liverpool, Elsevier science S.A. All rights reserved ,1997.

67. Washington-National Research council,2004,Accelerating Technology Transition ,(Washington ,D.C.,The National Academies Press ,2004) 36-38.

68. Yoshlaki-A.K. Yoshlaki,T.A.Keisuke ,Journal of Japan Society for compsite Materials, 25(1999).p(188-195).

69. Yoon - Seungchae Yoon, Soon –JiKHong , Sun Ig Hong , HyoungSeop Kim ," Mechanical Properties of Equal channel angular pressed powder extrudates of a rapidly solidified hypereutectic ,Al-20wt%Si Alloy", Materials science and Engineering A(449-451) ,2007.

70. ZEREN -MUZAFFER ZEREN and ERDEM KARAKULAK " Study on hardness and microstructure Characteristics of Sand cast (Al-Si- Cu alloys)",Indian Academy of Sciences,vol:32, No.6, pp.(617- 620) ,2009.