International Journal of New Technology and Research (IJNTR)
ISSN: 2454-4116, Volume-7, Issue-10, October 2021 Pages 01-08

Analysis of Developments on Mechanical Properties of 7xxx Series Aluminum Alloys: A Review

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***Abstract*— This paper analysis some studies of 7xxx series of high strength aluminum alloy and a trial has been made to focus on the processing, heat treatment, properties and applications of the 7xxx Al alloy from the present literature on the 7xxx alloy. The properties of mechanical having fatigue, tensile and fracture hardness properties which further discussed and timely supported and analyzing the experimental data. The main consequences are strain corrosion exfoliation and cracking corrosion and they are also reviewed mainly. The black color anodic coatings are generally used on aerospace self-propelled vehicles for thermo-optical properties and discussed their chemical characteristics of that black colored anodic thin films with mechanical and thermoplastic properties, and all this is considered as a main function of all operational conditions of particular method. There are few samples which were welded by traditionally methods using solo sides and bobbing tool friction stir welding processes considering different parameters of welding. There were compressive behavior and processing maps of cast, as-cast and extruded 7075 Al alloy taking identical grain size of 310-360 µm which further studied and equated with references. There are some works reported the fabrication of Al alloy 7075 with corundum Al2O3 particles of corundum and B4C considering stir casting methodology. After this the recrystallization nature of 7085 Al alloy in particular period of hot compression at many stages temperaturesrange of 563−733 K and strain rates of 0.011−10 s−1 which was tested using Electro-Probe Microanalyzer (EPMA), Electron Back Scattered Diffraction (EBSD) and Transmission microscopy (TEM). The main influences after considering ageing temperatures over mechanical properties, precipitation and corrosion behavior features of 7085 Al alloy and were investigated using intergranular corrosion tests, transmission microscopy, tensile testing and polarization curve measurement observation. Main aim of conducting this type of review analysis is to realize the fact of higher understanding of all parameters which are further governing the fatigue crack effects and discontinuities to facilitate the larger prediction of lifecycle of fatigueness.**

***Index Terms*— Transmission Microscopy, 7xxx Series, Electro-Probe Microanalyzer, Electron Back Scattered Diffraction, aerospace engineering.**

I. Introduction

There are many Aluminium alloys where Aluminium is main constitute. Copper, silicon, tin, zinc, magnesium and manganese are the main constituents of Aluminium alloys. The two main classes are casting alloys and wrought alloys. both these categories are splitting in the groups of non-heat and heat treatable. Nearly 80% of Aluminium is casting for shaped products and there are various examples like rolled foils, extrusions products and as rolled plate. Aluminium alloys products are very cost effective because of its low melting point and after this they are usually having low tensile strength comparing with wrought alloys. Al-Si alloy structure is very expensive where silicon constitutes 4-13% in casting characteristics. Aluminium alloys are mostly acknowledged in assemblies, machineries, erection, fabrication, welding also etc. and Al alloys are light weight and having corrosion resistance properties.

The alloys which are composed mainly of Aluminium were playing very important role in aerospace engineering and most of the aircrafts and space ships are using light weight layers of these alloys. On the other hand, Aluminium and manganese alloys are lighter than most of the Aluminium alloys. These are less igneous than alloys which holds a very large magnesium percentage.

The Aluminium alloy will produce white color surface and protecting layer of Aluminium are left out unprotected short of anodizing by accurate painting procedures. In many cases of environmental, the galvanic corrosion may arise Aluminium alloy and placed with electrical contacts and many other metals considering extra corrosion than Aluminium. An electrolyte presenting will permit ion exchange. This is mentioned as dissimilar corrosive metal, and this methodology may occur as extra which is wholly natural or as intergranular corrosion. The Aluminium alloys can be improperly treated in heat. All this can cause internal partition of element and after this the metal getting corrosion under many articles and products.

The Aluminium alloys were registered by 'The Aluminium Association'. There are many organizations which issues a very fine specific standards for manufacturing of Aluminium alloys as well as the other society like 'Automotive Engineers Standard Organization' which precisely examine aerospace standards subgroups and also American Society of Mechanical Engineer International.

There are many Aluminium alloys series used in aerospace industries. They are 7010, 7049, 7050, 7055, 7068, 7075, 7079, 7085, 7093, 7150, 7178, 7475 etc. which improves overall features and performance of Al-Zn-Mg-Cu alloys to encounter the main requirements of big aircrafts like A320 components which gains attention from industries. The very big scale production like bulk items and thick plates, the quenching sensitivity of Al-Zn-Mg-Cu alloys are critical factors and that should be considering because of an insufficient quenching rate at center of production results

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with poor mechanical properties. At 2002 the development of 7085 Aluminium alloy was developed by Alcoa and considered as new generation high strength thick plate alloy. These alloys are having higher fracture strength, fracture toughness and lower quenching sensitivity then previously produced 7050 Al alloy. The main behavior considering hot deformation was playing a vital factor for the development of alloy and applications. There was a little research considering hot deformation behavior of 7085 alloy, and especially using different heat treatment procedures. The main purpose of that study was for investigating the hot deformation behaviors of Al alloy 7085 under the variety of heat treatments. The big aim is to have the fruitful understanding the consequences of various heat treatments on hot deformation behavior of 7xxx series Al alloy.

II. LITERATURE REVIEW

According to W. F. Xu et all [1] all joints and slices are fractured abnormally using WNZ instead of HAZ for bottom and middle slices of FSW super thick plate and are defect free joint in the time of considering with moderate rotational speed of 600 rpm. Commonly both strength and elongation of this entire joint and top slice will weaken everywhere and presenting the zig zag like fracture structure. The middle and bottom pieces are 45^{o} shear fractured considering the tensile direction and eventually supported the ductile fracture types by dimples.

Mutually the microstructure features having grain size and microhardness distribution, precipitates morphology, misorientation and distribution area are main reasons for unpredictable fractures in WNZ for entire joints and top slice. The mini Taylor's factor will appear with in the WNZ top position and indicating the plastic deformation which occur during the tension. This ends up the superior crack in WNZ top position. Additionally, the Taylor's factor presents in HAZ can compare with WNZ middle position and bottom position. This way the strain is very intense in WNZ top position, this contains the very big area for grain fraction and with high strain at the time of tension with the whole joint and slice. Same way the middle slice and bottom slices are having no concentration of strain and are repeatedly found in WNZ middle slice and bottom slice. Thereafter the strain will increase regularly in HAZ with rise of minimum nominal stress. This combined action with three factors which are initiating crack in WNZ for whole joints and top, middle and bottom slices in HAZ which considering tension time and lastly initiating fracture with whole zone.

According to T. R. Prabhu [2], the 7085 Aluminium alloy will be potential replacement of 707x and 705x series considering the aero plane's airframe applications like wing spar, bulkheads, fuselage frames, landing gears etc. They choose ingot producing process route for the alloy. For standard homogenization temperature of alloy, it should be little below 500^{o}C and in order of that, the eutectics melt and the clear Al_3Zr can smoothly form them to help in grain refinement to prevent the recrystallization at the time of forming operation. The finest deformation temperature and strain rate for smooth working of 7085 Aluminium alloy were found to be around 440^{o}C and 0.0001 s^{-1}. Standardized distribution of nano like fine size of Cu enhanced Ƞ precipitates in grains and thereafter the minute distribution of uneven coarse sized copper riched Ƞ precipitates with the limitations of grain which are seriously looks like microstructure to receive the simplest SCC resistance with not losing the strengthen properties of alloy. Dual retrogression and re-ageing of DRRA, the first most acceptable temper situations to optimize the SCC resistance and thereafter the power of the alloy. The alloy's mechanical properties are insensitive for the thickness up-to the range of 310 mm and is very sensitive to the sample orientation, quenching rate, strain concentration and temperature over 180^{o}C. The main strength considering reference to heating temper treatment that has the successive increasing classification. With considering reference to SCC, the heating temper treatment is having HLA\T6\RRA & T74 & DRRA sequence.

Yann Goueffona et al [3] presents the study of chemical features of black anodizing thin film, with also as their thermo and mechanical optical properties like a function of operational conditions of methodology. The main effect of anodized parameters was seen to interrupting the morphology of porosity and thickness. Mainly, electrolytic temperature was considered to hold a main feature on porosity because this is changing the chemical kinetics from little amount of anodization. This affects on preparatory steps of Young's modulus and this is also examined. The sealing and coloring steps appear to modify the mechanical properties at coating surface and leads to Young's modulus within the thin film. And at last, degrading of porosity on film bounds the risk of crazing other than the flaking, although thermo optical properties are not affected by this.

Weifeng Xu et al [4] did their experiment on 12 mm 7085-T7452 Al alloy thick plate which was joined by traditionally single side and bobbing tool friction stir welding. After that the microstructure, temperature distribution and mechanical properties of this joint with thickness directions are intimately investigated. The assumptions are distribution of axis of thickness directions which is non uniform for SS-FSW joints and also showing the decreasing tendencies. On the other hand, the temperature of lower shoulders is affected zones and it was nominally above the upper shoulder of BB-FSW joints. This is introducing the smaller way of axis within the thickness direction. Failure are initiated from HAZ for SS-FSW samples with the ductile like fractures, whereas the fractures mode is changed to brittle fracture under the WNZ for BB-FSW samples.

Manu Khare et al [6] offered research report on the fabrication of 7075 Al alloy which is reinforced with alumina Al_2O_3 particles and boron carbide B_4C by stir casting procedural technique. This research was completed in two stages. In first stage, signal to noise and orthogonal array was deployed to analyses the effect of process parameters on dry sliding wear nature of composites which is reinforced with frequently changing weight percentage of Al_2O_3 i.e. 8,10 and 12% constituent part of particles. On other side, second stage is optimizing the weight ratio of Al_2O_3 nearly 12% and it is selected from the first stage. After this it is reinforced with varying weight percentages of B_4C i.e. 2,3 and 4 %. The three level FCC experiment was developed by receiving different responses from surface methodology. The work is concluded and results shows that Al/ Al_2O_3 fabrication was done successfully. Taguchi method was used to work with consequences of sliding speed, sliding distance, load and reinforcement ratio on wear of dry sliding behavior of Al/ Al_2O_3.

Yan Zou et al [7] finished their research work by experiment to find the corrosion behavior, mechanical properties and microstructure of 7085 Al alloy using varying temperatures and also it is investigated. By the result of used methodology, the sequence of 7085 alloy precipitation at 90°C and 150°C is different and this can be briefed as SSSS/GP ZONE-1/ GP ZONE-II/ Ŋ` phase at 90°C for ageing and SSSS / GP ZONE-11 / Ŋ` phase at 150°C for ageing. 7085 alloy gains highest age at 90°C and it has an improved combination of ductility and strength compare to 150°C. Improved hardenability for samples of best aged at 90°C is by the reasons of pre dominance of GP-II zones, on the other side the leading established precipitate is Ŋ` phase comparing with 150°C peak aged sample. 7085 alloy having corrosion resistance is very strongly reliant on parameters of heat treatment. This was seen that better ageing temperature and elongated ageing time improves the resistance against corrosion, and this is owing for the formation of Ŋ phases like plate considering with grain boundaries and better Cu content in GBP.

Baohua Nie et al [8] used two different types of Aluminium alloy ingots with using minimum chemical composition of 7050 and 7085 alloys and then get prepared. Both the ingots are homogenized by very slow heating nearly 450°C and held on that temperature for 24 hrs and cooled in air after completion of heating. Now after pre heating for 1 hr at 400°C this homogenized ingots were rolled to sheets by passing through number of passes. These rolled sheets then sliced into rectangular samples of size 20x20x4 mm. After heat treatment of solution for 60 mins at 470°C, these samples were water quenched at room temperature and then under normal atmosphere. Thereafter these samples were artificially aged for 24 hrs. at 120°C. The quenching process cooling curves were attained using thermocouples which were soldered with samples and it is also having air or water nearby the tip of thermocouples. The period of detecting was nearly 0.04 sec and Figure 1 shows the rate of cooling of air quenched sample which was lower as compare to water quenched sample. The Vickers hardness of sample was also tested on HV-10A machine considering 3 kg load. There are six measurements which were made on every sample for getting an average value. This is seen that the microstructure was detected after using a JEOL JEM 2100 electron microscope which was operated at 200 kV. The specimens of 3 mm diameter and with 80 mm thickness were electropolished by using 30% HNO_3 + 70% CH_3OH solution below -20 °C for electron microscope observation.

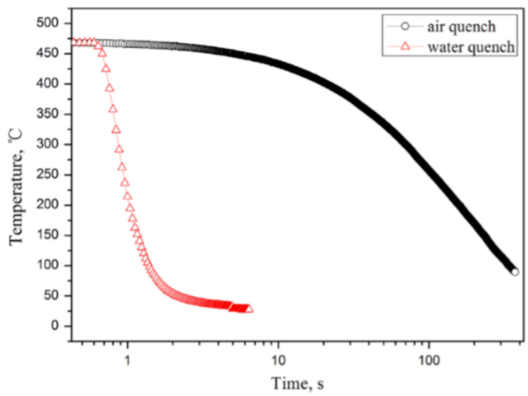


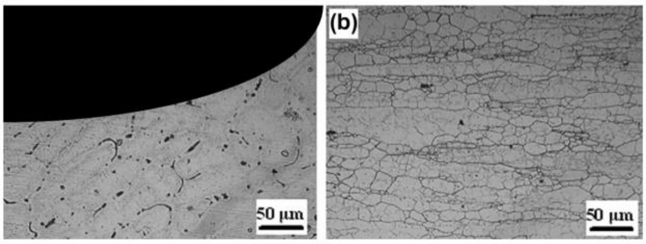
Fig1-Cooling curve during the water and air quenching processes

Songyi Chen et al [9] did their work on ingot metallurgy route in laboratory of prepared materials. The raw material constitutes 99.9% Al, 99.9% Mg and 99% Zn. This material is also having Al-Cu and Al-Zr alloys and smelted in alloy. The temperature of smelting was kept at the range of 705-745°C. After this molten metal was poured into the molds through partial continuous casting. Table 1 shows the chemical composition of 7085 Al alloy which was resolute by Inductively Coupled Plasma ICP. Now the specimens were treated to heat treatment and homogenization. Homogenization treatment process consist of billets for 24 hrs at 450°C and 30 hrs at 470°C, then slow cooling at temperature. Next the treatment of solution was consisting of homogenized billets that was forged and then solution treatment for 1 hr at 470°C, then after quenching by water. The samples were cylinder in shape of Φ10 mm and height of 15 mm were machined from plates of solution treatment and homogenization billets. Afterward the compression test was conducted on GLEEBLE 1500 machine with strain rate of 0.0001 s^{-1} to 1.0 s^{-1} at a temperature range of 305-455°C. The samples now induction heated for the deformation considering a heating rate of 10°C/s by controlled AC current thermocouple feedback and then after they were seized for 3 min at deformation temperature to obtain an even and undeviating temperature past to deformation. Afterward, the samples were compressed for reduction up to the range of 50% and instantly cover by water quenching to freeze the already deformed microstructure. With the intention to reduce the frictional forces between press indenters and samples, the isothermal compression tests were conducted using graphite lubricant. Later with the help of Transmission Electron Microscope JEOL2100F and optical microscope, microstructures of deformed specimens were investigated. Now, thin foils were prepared by polishing up to 100 µm for transmission electron microscope testing and twin jet electro polishing which considered a temperature at -25°C in solution of 25% HNO3 + 75% CH3OH.

Table1-Chemical composition of AA7085

Element	Zn	Mg	Cu	Zr	Al
Weight %	7.5	1.6	1.5	0.12	Balance

The result of above testing shows the early microstructures of alloy after heat treatment as shown in figure 2. Then for the alloys after treatment for homogenization, it is seen that grain size is nearly 100 µm and course particles are distributed around grain boundaries. Now for the alloy after treatment of solution the size of grain is nearly 30 µm and there is a minute coarse particle around the grain boundaries.



(a) homogenization treatment (b) solution treatment

Fig2-The initial microstructure of the alloy after different heat treatment

Songyi Chen et al [10], were involved in the study which was carried out on hot forged 7085 Al alloy of 150 mm thick plate with composition of Al–7.15, Mg–1.45, Zr–0.06, Zn–1.75, Cu–0.12, Fe–0.02 and Si wt.%. The sample plate was solution treated for 1hr at 470°C and quenched in atmospheric temperature water and undertaken on several ageing treatments of T6, T74, RRA, DRRA and HLA. Table 2 lists the heat treatment procedures in details.

Table2-Heat treatment procedures used for the 7085-aluminum alloy.

Temper	Heat Treatment
T6	120° C/24h
T74	110°C/6h + 160°C/10h
RRA	120°C/24h + 180°C/0.5h + 120°C/24h
DRRA	120°C/24h + 180°C/0.5h + 120°C/12h + 180°C/0.5h + 120°C/24h
HLA	200°C/5 min + 120°C/24h

The mechanical properties testing of specimen were performed on INSTRON 3369 testing machine at room temperature with 2mm/min tensile speed. The width of specimen and gauge length of specimen were 6x25mm, respectively. The EXCO Accelerated Exfoliation Corrosion Test were also performed rendering to standard EXCO test and it is also described in ASTM G34-01 [21]. Finally, the temperature of solution was maintained at 25°C and the solution was 4.0 M NaCl+ 0.5 M KNO_3 + 0.1 M HNO_3 of EXCO test.

Results of this test is shown in fig. 3 and shows the mechanical properties of 7085 Aluminium alloy at several tempers. This is clearly shown in fig that on temper sample of T6, yield strength and tensile strength was 530 MPs and 582 MPa respectively. Comparing this with T74 temper samples, the YS and UTS is decreased by nearly 13.6% and 9.6% individually. This is also seen that YS and UTS is 528 MPa and 578 MPa for RRA temper samples. RRA is little lower against comparison of T6 temper sample but then comparatively higher than T74 temper sample. The DRRA temper samples were similar to RRA temper sample. Moreover, if it is compared with T6 temper sample, the YS and UTS of HLA temper sample was received little decrement such as 18.8% and 12.5% respectively. At last, the figure shows the strength in order of T6 > RRA> DRRA> T74> HLA.

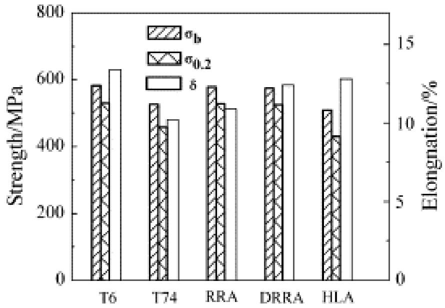


Fig3-Mechanical properties of the 7085-aluminum alloy under different heat treatment.

According to Song Yi Chen et al [11], the experiment was focused on 7085 Al alloy being hot forged and had chemical composition of Al−7.5, Mg−1.5, Zn−1.6, Cu−0.12, Fe−0.02, Zr−0.06, Si (%, mass fraction). Table 3 shows the heat treatment procedures. The slow strain rate test SSRT was evaluated the SCC susceptibility and was tested at a value of 3.3×10−7 s−1 strain rate in atmosphere and in NaCl 3% mass fraction + H_2O_2 0.5% volume fraction, respectively. Here, specimens of rectangular shape with a 30 mm length and 6 mm width were used. The vulnerability to SCC was also calculated using the ratio of Loss of Elongation (LE). Then the expression was considered as $I_{SSRT}= I_{Corr}/I_{Air}$, where, I_{Air} is the elongation in corrosion solution, I_{Corr} is the elongation in air. The test for fracture toughness were carried out in transverse longitudinal procedure which is according to Kahn method. Method was used after pulling a notched thin sample of 2.54 mm thick at constant velocity, having no previous fatigue crack signs, but the tip radius should be lower than 0.025 mm. Here, the notch resistance was considered by Unit Initiation Energy UIE. The test was performed on smooth plate sample for finding mechanical properties by an Instron 3369 testing machine at atmospheric temperature with tensile velocity of 2 mm/min. The sample length and width are 25x6 mm respectively. The microstructures were studied by TEM (JEOL- 2100F) worked at 200 kV. The thin foil was prepared by polishing for TEM up to the size of 100 µm and later twin jet electro polishing at -25 °C of 75% CH3OH+25% HNO3 volume friction.

Table3-Heat treatment procedures used for the 7085-aluminum alloy.

Temper	Heat Treatment
T6	120° C/24h
T74	110°C/6h + 160°C/10h
RRA	120°C/24h + 180°C/0.5h + 120°C/24h
DRRA	120°C/24h + 180°C/0.5h + 120°C/12h + 180°C/0.5h + 120°C/24h

Figure 4 shows the results from above testing of slow strain rate in 0.5% H_2O_2+3% NaCl and in atmosphere under different types of heat treatments. It was found that both elongation and tensile strength of samples in 0.5% H_2O_2+3% NaCl solution was lower as compare to those in atmosphere, this representing that the alloy had the susceptibility SCC. On the other hand, to know the connection between SCC and heat treatment, the effective method to estimate SCC resistance of Al alloy is ISSRT. It was seen that for better SCC resistance gives higher ISSRT. It is clear that ISSRT increases in sequence of T6<RRA<DRRA≈T74. Here, highest SCC susceptibility is shown by T6 temper sample. SCC resistance is similar to T74 but DRRA temper sample is higher as compared to T6 and RRA.

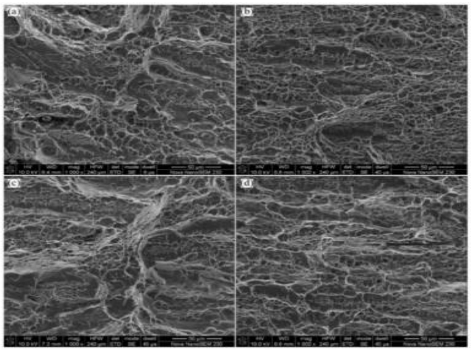


Fig4-Fracture morphologies of AA7085 under different heat treatment
(a) T6 (b)T74 (c) RRA (d) DRRA

Yu Lin Zheng et al [13] used the samples having length, width and thickness dimensions of 125x25x25 mm and it was cut from ingot and endangered to homogenization, which slowly heated for 48 hrs, 192 hrs and 384 hrs at 465°C and after this cooling in atmosphere. Then, afterward re-heated to 470°C and 1 hr extra holding in air furnace, further specimen was cooled at atmospheric temperature by exposing by one end to vertical flow of cold water [14], then further aging at 120°C under oil bath for 24 hrs. The matured sample was then orderly cut into two parts and then grounded, polished and hardness on center layer was experienced along longitudinal direction. The Vickers Hardness Testing was tested on HV-10B hard meter with 29.4kN load and five measurements were completed at each location to attain an average value.

Table4- Chemical compositions of studied 7085 aluminum alloy (mass fraction, %)

Element	Zn	Mg	Cu	Zr	Fe	Si	Ti	Al
Weight %	7.52	1.61	1.74	0.11	< 0.08	< 0.06	< 0.05	Balance

The thin sample slices at dissimilar locations say d=3, 78 mm from one end of water cooled and other end is quenched which were cut for the purpose of examine the microstructure of sample. After grinding and polishing, the sample slices were going under the process of etching with the reagent made up of 16mL HNO_3, 1mL HF and 3g CrO_3. It was also using 83 ml of distilled water and then examined on XJP-6A optical microscope OM. Here, the polished specimen was also examined on FEI Quanta-200 Scanning Electron Microscope SEM for examine the particles of second phase.

Foils of 3 mm diameter and 0.08 mm thickness were ready and electropolished below in -20°C for 80% CH_3OH+20% HNO_3 solution and then observed on FEI Tecnai G2 20 Transmission Electron Microscope TEM worked at 200 kV for investigate the dispersoids and strengthening the precipitates.

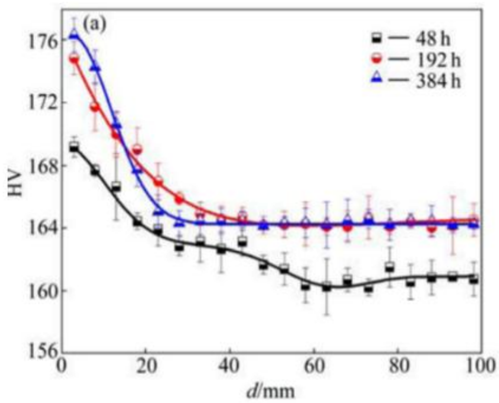


Fig5-Influnce of homogenization time on hardness (hardness retention value)

Figure 5 shows the impact of homogenization time on the hardness of end quenched samples after maturing. Homogenization period had a important impact on the hardness value. At the value of d=3 mm, the hardness was amplified obviously with time and growing from 48 hrs to 192 hrs, but also slightly increased from 192 hrs to 384 hrs. Afterward, over the complete distance, samples for homogenized 48 hrs hardness is quite higher compared to samples of homogenized 192 hrs and 384 hrs. In graph, shape of curve was similar i. e, the hardness is declining with the growing of distance from one end of water cooled. Similar for the sample of homogenized for 48 hrs, the hardness was reduced very rapidly within the distance of 30 mm but slow from 30 mm to 70 mm, and it looks likes to be persistent with the extra increase of distance. For the homogenized specimens for 192 hrs and 384 hrs, the rapidly decreased in hardness with the distance gaining within nearly 45 mm and 30 mm respectively and then look likes to be constant.

Figure 6 show the pictures of optical micrographs for the homogenized samples for 48 hrs and 384 hrs. A very number of equiaxed, grains might be got in both samples and sizes were closely similar to about 200 μm. Consequently, it is supposed that homogenization time had no conclusion on the value of grain margins in the samples. Furthermore, few black phase atoms could be acknowledged and most of them were positioned at grain boundaries.

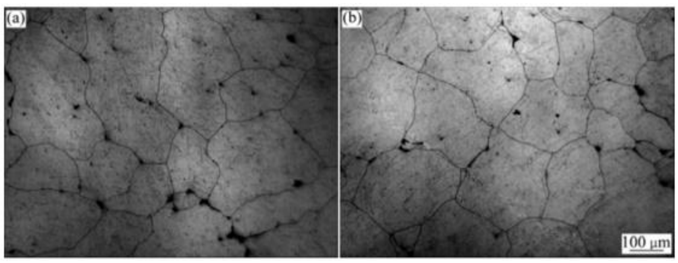


Fig6-Optical micrographs of specimens homogenized for different time (a) 48h (b) 384h

Song-Yi CHEN [15] finished their experiments which was conducted on 7085 Al alloy with having main chemical constituents of 1.6% Mg, 7.5% Zn, 0.12% Zr, 1.5% Cu and Al is balance (mass fraction). The sample was cut from homogenized billets of Φ10 mm and 15 mm height for machining. The test for compression was conducted with strain rate of 0.0001−1 s^{-1} at deformation temperature of 350-450°C. Before beginning of compression, the specimens were pre heated to deformation temperature at heating frequency of 10°C/s and sample was seized at the temperature for 3 min. The strain recorded was 1.38 and the specimens were quenched instantly after compression. With the aim to reduce the frictional force among the samples and press indenters, a graphite lubricating oil was used at the duration of isothermal compression tests. The microstructures of specimens were tested and examined with the help of using Optical Microscopy OM and Transmission Electron Microscopy TEM. Specimens for optical microscopy comments were chemically engraved in Graff's reagent having formula 16 mL HNO_3 + 1 mL HF + 83 mL H_2O + 3 g CrO_3. The fraction of recrystallized grains was determined by optical micrographs using area counting present on it. The average grain dimensions were measured by the means of linear intercept method. The measured values were the average of nearly 100 grains. The thin foils for TEM observation were ready by mechanical polish to 100 µm and then twin jet polishing at -25°C in a liquid solution of 75% CH_3OH + 25% HNO_3. The samples for mechanical properties testing were isothermally compressed at varying temperatures and strain of 1.38 with strain rate of 0.005 s^{-1}. Samples were further solution treated for 1 hr at 470°C and artificially matured for 24 hrs at 120°C. Afterward, mechanical properties investigation were done on evenly plate samples by Instron 3369 test machine at atmospheric temperature with tensile velocity of 2 mm/min. The gauge length and the thickness of the samples were 25x2 mm respectively. The V shaping methodology were used to understand the fracture hardness and toughness.

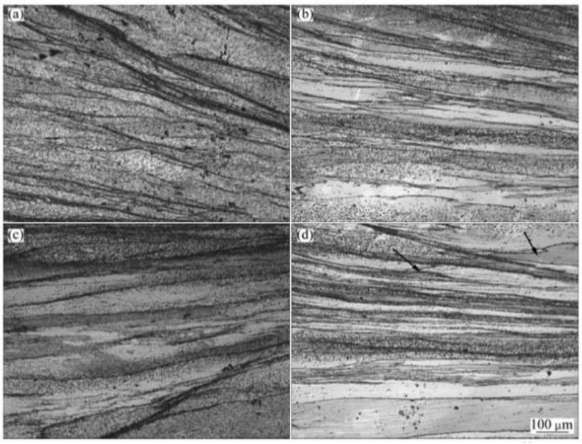


Fig7-Optical microstructure of specimens deformed under different Z parameters

(a) Z=4.78 x 10^{14} (b) Z=4.78 x 10^{12} (c) Z=3.27 x 10^{11} (d) Z=3.24 x 10^{10}

Results of above experiment is shown in figure 7 and shows the typical optical micrograph of the alloys distorted under different Zener-Hollomon (Z) parameters. The starting grains are enlarged and a handsome quantity of second particles are circulated within the grains. Under intermediate and high Z parameters, it sees that there were no recrystallized grains observed along with the grain boundaries which specifies the existence of dynamic recrystallization as shown in figure 7d.

Song Yi CHEN [16] did research on experiment which were approved out on 7085 Al alloy considering with main chemical compositions such as 1.6% Mg, 7.5% Zn, 0.12% Zr, 1.5% Cu and Al (balance mass fraction in %). The samples were further subjected to solution heat treatment and homogenization. For the successful completion of test, the homogenization treatment was as, the homogenized billets had strain of 3 with forged billet at 400-450°C and then solution treated for 1 hr at 470°C followed by quenching in water. Author took the cylindrical specimen of Φ10x15mm height stayed machined from the solution treated plates and homogenized billets. The compression tests were carried out on Gleeble 1500 at strain rate from 0.0001 s^{-1} to 1 s^{-1} at a temperature of 300 to 450°C. Before doing the compression, samples were heated near deformation temperature at heating rate of 10 °C/s and afterward held for 3 min at deformation temperature. Later, the samples were compressed equal to the range of 50% reduction and instantly water quenched. So, in order to reduce the forces by friction between the samples and press indenters, a graphite lubrication oil was successfully used at the time of isothermal compression tests. The microstructures of deformed samples were tested and examined by Optical Microscope and Transmission Electron Microscopy (JEOL-2100F). The thin foils using in TEM were prepared up to the size of 80-100 µm by mechanical polishing and lastly double jet electro polishing at -25°C in solution of 75% CH_3OH + 25% HNO_3 respectively.

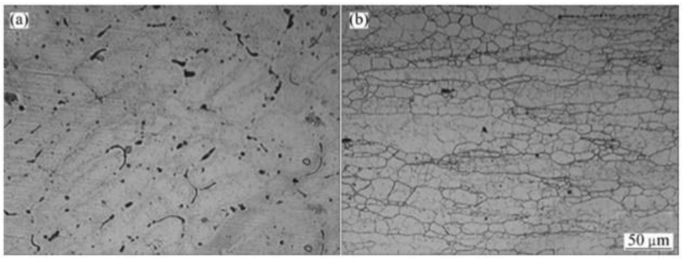


Fig8-Initial microstructure of alloys (a) As-homogenized (b) As-solution treated

Above tests presents the starting microstructures of two alloys which are heat treated as shown in Figure 8. This is clear that for as-homogenized alloy, the size of grains is nearly 100 µm and few undissolved primary particles was distributed with the grains border. It was seen that the particles were possibly undissolved in S-phase $A1_2CuMg$ as shown in figure 8a. Moreover, the grain dimensions are nearly 30 µm and there are some uneven particles on grain boundaries as shown in figure 8b for as-solution treated alloys.

Shengdan Liu et al [17] did their experiment on a 7085 Al alloy which was direct chilled and had 450 mm thickness and prepared in laboratory. The main chemical compositions were observed by Spectro Blue Sop Inductively Coupled Plasma Optical Emission Spectroscopy and shows the results in weight percentage as Zn-1.58, Al-7.46, Cu-0.09, Mg1.67. After compilation of homogenization by heating slowly for 24 hrs at 733K, the ingots were exposed to multiple pass hot rolling and obtained 163 mm thick plate. Subsequently, the microstructure is commonly not uniform nearby the normal direction in the plate [18], the specimens for successive experiments were cut from the surface thin film as presented in figure 9 and Figure 10. Both figures show the graphical procedure considered by author.

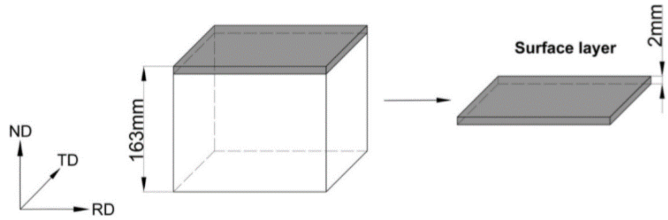


Fig9-Schematic of sampling RD-rolling direction, TD-transverse direction, ND-normal direction

The methodology taken by author for examine the grain structures, author prepared samples which were prepared by standard metallographic method and etched by Graff's Sargent reagent which contained 16 mL HNO_3, 1 mL HF 83 mL, H_2O and 3 g CrO_3. After this the sample was observed on optical microscopy (Olympus BX51RF). Then the microstructure was investigated by high resolution and conventional Transmission Electron Microscopy TEM and further investigated by Scanning Transmission Electron Microscopy STEM. Afterward, samples of 0.08 mm thick and 3 mm diameter was prepared. Now after electro polishing by solution at -293 K containing 20% Nitric acid + 80% Ethanol under liquid nitrogen. Specimen were tested on Tecnai G2 F20 STEM with High Angle Annular Dark Field HAADF detector and operated probe at 200 kV.

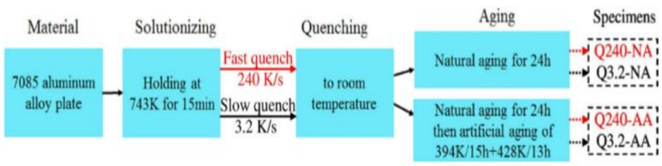


Fig10-Schematics of the experimental procedures

III. CONCLUSION

The study delivers the overview on machinability of Metal Matrix Composition. Huge experimental trials and variety of solutions have been completed for the present traditional particulate reinforced composition exclusively for Aluminium Metal Matrix Composites AMMC. This literature provides the highlights the properties of 7xxx Aluminium alloy for MMC and many other MMC's also. The procedure and methodology suggested by various authors gave light to the developments made in the field of composites. Aluminium alloy 7075 shows excellent resistance over corrosion under various atmospheric and marine conditions. In many conditions, this property of 7xxx alloy can be further improved by anodic treatment. Alloy 7xxx includes various type of typical applications like aerospace, aircraft components, transports, camera lenses, electrical fittings, connectors, marine fittings, bicycle frames, drive shafts, valves, couplings, brake components etc. The ductility of 7xxx alloys empowers castings to be corrected easily or even improved modification in shape.

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