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EFFECT OF HIGH TEMPERATURES ON TENSILE DEFORMATION BEHAVIOUR OF CAST AL 7178 ALLOY

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ABSTRACT

The current study carries to investigate the high-temperature tensile deformation behavior of Al 7178 alloy. Cast metal matrix samples were produced through the stir casting technique with Al 7178 alloy is reinforced with SiC and Al_2O_3. The cast samples were tested under a uniaxial tensile machine at temperature ranges 400oC and 500oC. In high-temperature results, the Al 7178 alloy shows a decrease in strength with increasing temperature. In this investigation tensile strength, yield strength, and elongation were studied while tensile true stress and true strain curves were generated using Instom tensile machine.

KEYWORDS: *AL 7178 Alloy, Tensile Deformation*

INTRODUCTION

Napoleon and Satish Kemar G studied that aluminum alloy 5052 has been tested by hot tensile strength at 560^{o}C, 570^{o}C, and 580^{o}C. The chemical composition and microstructure of AA 5052 was studied. Finally, superplastic is formed and analyzes the super plastic material parameters. They revealed that temperature increases with decreasing stress while increasing strain at a particular temperature during the tensile test [1] Parag Armutkar et al explored that aluminum compound (A413) has been tried under hot tensile test. The strength of aluminum material is diminished ceaselessly for a higher strain rate of 0.1 per 0.1minute the elasticity at first increments as temperature increments from 150^{o}C to 250^{o}C. The strength diminishes to temperature from 50^{o}C to 300^{o}C. Generally, the true stress and true strain curve is constantly used to investigate the plastic deformation temperature and strain rate[2]. Hossen Vafaeenezhd et al examined that Sn-5sb composite is tried by a hot tensile test at various temperatures 300^{o}C, 350^{o}C, and 400^{o}C. In this research, the steady flow and formability conduct of Sn-5sb was examined. Based on two distinctive test FEM investigations of unsteadiness and break rules, the event of crack during a few framing cycles can be effectuated displayed. It was resolved that the ideal deformation condition with break probability 300K-400K and 0.001S-1[3]. Elanghovan Natesan et al examined that aluminum alloy A 356-T7 tried by uniaxial fatigue tests were completed at 150^{o}C, 200^{o}C, and 250^{o}C. The exploratory information of the cycle deformation conduct is adjusted against a nonlinear consolidated kinematic-isotropic hardening model with both a linear and nonlinear back stress. The material shows diminishing strength and expanding ductility with expanding temperatures under monotonic loading. The material shows strain hardening at a temperature below 150^{o}C and a strain rate softening at a temperature above 150^{o}C under uniaxial loading

[4] Ravindrandh Bobbili et al considered the strain rate tensile conduct of 7017 aluminum alloy at different strain rates and temperatures. It is noticed the flow stress diminishes with an expansion in temperature. The 7017 aluminum alloy shows thermal softening at a higher temperature when temperature more than 200^{o}C at strain rates, thermal softening is the transcendent method of deformation mechanism. The crack plane at a high strain rate at different temperatures is generally made out of a dimple design. It is discovered that temperature to 200^{o}C, the quantity of dimples rises and dimple size is bigger than that at lower temperature [5 L Ceschini et al(2014) considered that the high-temperature tensile conduct of A354 aluminum alloy is tried by utilizing a hot tensile test at room temperature to 200^{o}C, after HIP and heat treatment. They revealed that the mechanical characterization of tensile and yield strength are diminishing with temperature expands, hardness and elongation are expanding with temperature builds as a result of thickness changes [6]. Sung-Hwan cha et al examined that the high-temperature tensile conduct of new Al-1%Mg-1.1%Si-1.8% CoNi, heat resistance is powder ball processing and casting. The high-temperature tensile test was directed at different temperatures from 25^{o}C to 450^{o}C. They noted that new obstruction alloy have superior properties at high temperature no decrease up to 200^{o}C. The tensile strength diminishes and extension increments at 450^{o}C which demonstrates excellent heat treatment because of the CO-NI phase [7}. Li Xin et al (2018) considered hot deformation conduct on aluminum compound AA2219 under the uni-axial tensile test are led at temperature goes from 415^{o}C to 515^{o}C and strain rates are 0.001S-1 and 0.01S-1. They releaved that examination of the strain rate coefficient demonstrates the AA 2219-O displays super plasticity at a temperature above 425^{o}C because of oxide contamination [8].

EXPERIMENTATION

Material

Present examination work Al 7178 has been chosen. The piece of Al 7178 composite is appeared in the table 1.

Table 1: Chemical Composition of Al 7178 Alloy

Elements	Zn	Mg	Cu	Cr	Si	Fe	Mn	Ti	Al
Wt %	6.3	2.75	2	0.23	0.4	0.5	0.3	0.2	88.32

Preparation of Hot Tensile Test Specimens

Al 7178 alloy is set up with a die casting for a hot ductile test. The castings are as per ASTM (American Section of the International Association for Testing Materials) guidelines on an exceptionally lathe machine. The hot tensile test sample size of 15 mm hold distance across, 20 mm grip length, 36 mm gauge length, 45 mm length of diminished cross- section area, an inner diameter of 9 mm and total length 200 mm and range of the filet is 8mm. it is appeared in figure 6.28 and casting sample were machined a role as appeared in the figures.

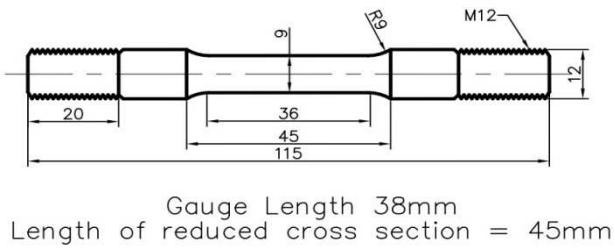

Figure 1: Dimensions of Hot Tensile Test Specimen.

Figure 2: AA 7178 Specimens for Hot Tensile Test.

AA 7178 Reinforced With SiC and Al_2O_3

AA 7178 metal is strengthened with a weight level of 3% of SiC and Al_2O_3 reinforcement material to arranged AA 7178 castings with die and stir casting for hot tensile test. The AA 7178 castings are machined as measurements of ASTM guidelines utilizing a complex machine for hot malleable test. The machined examples are appeared in figures

Figure 3: AA 7178/ Wt of 3% SiC Specimens for Hot Tensile Test.

Hot Tensile Test

The hot tensile test is the technique for testing the fundamental mechanical properties of the material at high temperatures. The tensile test machine is an INSRTRON model universal testing machine with a greatest load of 1000KN and equipped for heating to 1800^{o}C. AA 7178 and its composites are ready for hot tensile testing utilizing a die and stir casting processes. The casted examples are machined a role as standard details. The tensile test is led in a testing machine at various temperatures at a steady strain rate. The Engineering stress and strain curve is acquired from the tensile test of ductile metals. The tensile testing machine is appeared in the figure 4.

Figure 5 shows the machined AA 7178 examples are set inside a function. Fit for heating to 1800^{o}C. The sample are heated to 400^{o}C, 500^{o}C, and 600^{o}C for 30minutes soaking time during the process, the samples are loaded into the test frame where an extensometer measures the strain on the as the load is expanding. The examples were broken at most extreme load to get tensile strength for required temperatures. The tried examples are appeared in figures

Figure 4: Hot Tensile Testing Machine.

Figure 5: AA 7178 Tested Specimen.

Figure 6: AA 7178/SiC Tested Specimen.

RESULTS AND DISCUSSIONS

AA 7178 and its metal matrix composites were directed in a hot tensile test. The stress and strain curves were plotted for various testing temperatures. The flow and broke properties got from the tension tests were subject to the temperature at which the tests were conducted. In general strength diminishes and ductility increments as the test temperature are expanded. However, structural changes such as precipitation and re crystallization may happen in certain temperature ranges. The test outcomes are appeared in the table.

Figures 7, 8, and 9 shows the stress position curve for the AA 7178 acquired from the tensile test at high temperatures. The curve comprises three areas, the beginning plastic deformation, stable and crack deformation at a similar temperature. The flow stress of the alloy continuously expanded as the strain rate increments since separation piles were formed accordingly deformation of alloy. Additionally, the most extreme stress and yield stress of the Al 7178 alloy step by step diminished as the temperature expands due to the conditioning of the softening of alloy. The dynamic recovery and re crystallization result about diminishing deformation.

Table 2: Hot Tensile Test Results of AA 7178

S. No	Particulars	Units	400oC	500oC	600oC
1	Tensile strength	MPa	9.52	5.62	2.9
2	Yield strength	MPa	6.84	2.2	1.68
3	Elongation	%	1.1	1.4	1.6

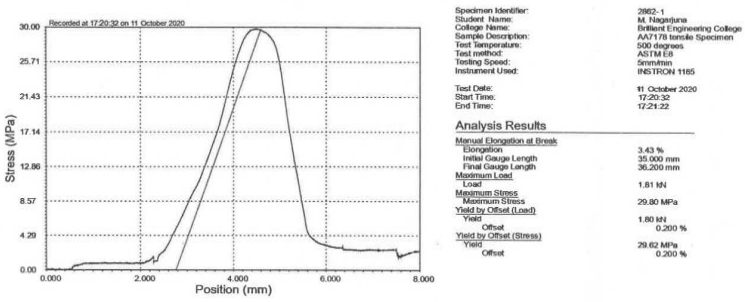

Figure 7: Stress and Position Curve for Al 7178 under Deformation Temperature 400°C.

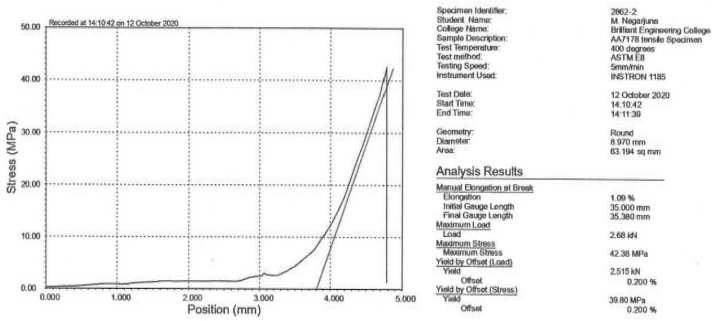

Figure 8: Stress and Position Curve for Al 7178 under Deformation Temperature 500°C.

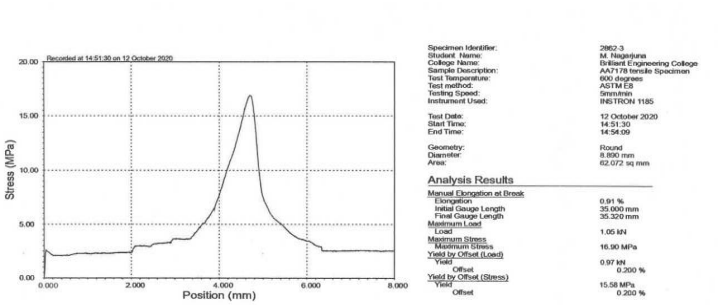

Figure 9: Stress and Position Curve for Al 7178 under Deformation Temperature 600°C.

Reinforced of AA 7178 with SiC

Tensile tests were conducted at various temperatures of metal matrix samples. The stress and strain curves were generated in a tensile machine. The test results are shown in tables.

Figures 10.11 and 12 shows demonstrated the stress position curve for the AA 7178/SiC acquired from the tensile test at various temperatures. It was seen that the most extreme stress and yield stress of Al 7178/SiC alloy slowly diminished as the temperature expanding as a result of the conditioning of the alloy.

Table 2: Tensile Test Results of AA 7178/ SiC- 3 %

S. No	Particulars	Units	400oC	500oC	600oC
1	Tensile Strength	MPa	9.4	5.82	2.68
2	Yield Strength	MPa	6.76	2.8	1.82
3	Elongation	%	1	1.3	1.9

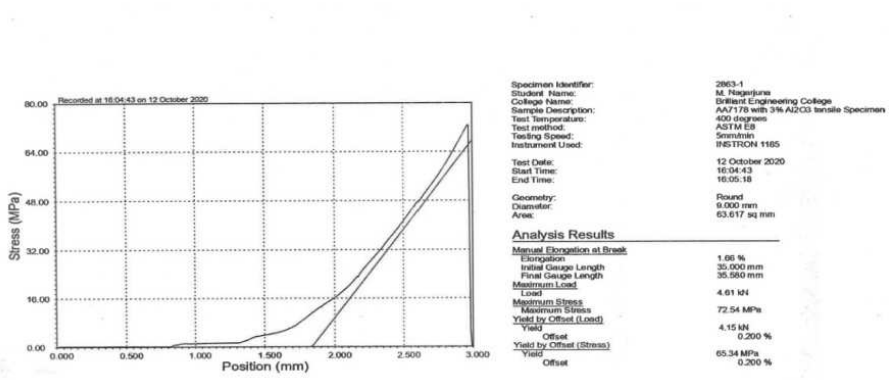

Figure 10: Stress and Position Curve for Al 7178/SiC under Deformation Temperature 400°C.

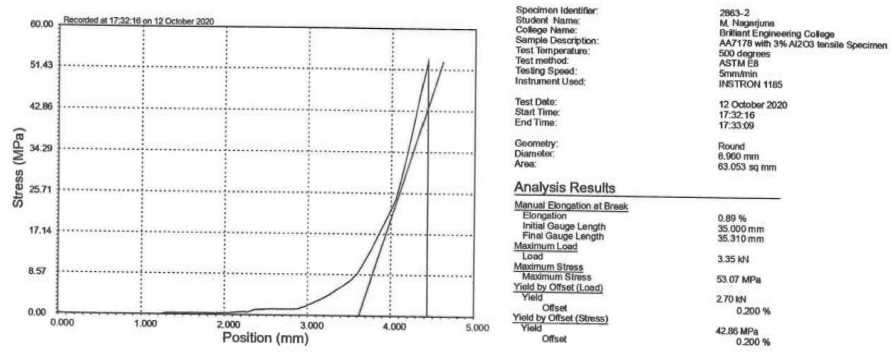

Figure 11: Stress and Position Curve for Al 7178/SiC under Deformation Temperature 500°C.

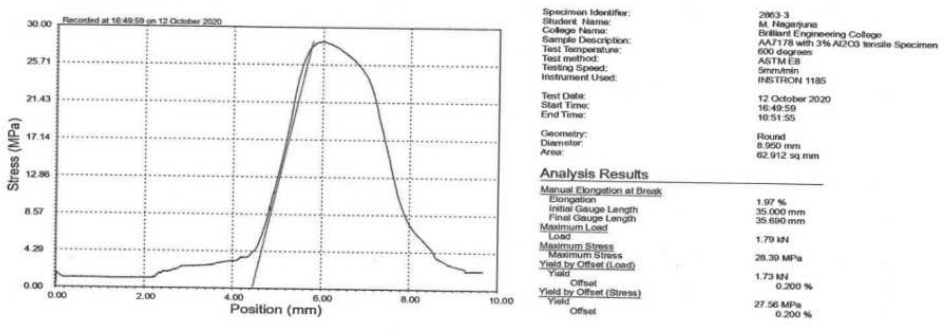

Figure 12: Stress and Position Curve for Al 7178/SiC under Deformation Temperature 600°C.

CONCLUSIONS

The deformation behavior of the Al 7178 alloy was investigated by a hot tensile test at different temperatures ranging from 4000C to 600oC. The following conclusions are

- Maximum stress and yield stress of Al 7178 decreases with increasing deformation temperature because of dynamic recovery and re crystallization.
- Reinforcing the Al 7178 with 3 % weight of SiC particle lead to increase the maximum stress and yield stress by 43.99 % and 43.43 %.
- Elongation of Al 7178 increases with increasing temperature due to re crystallization.

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