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Materials Today: Proceedings

Available online 12 June 2024

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Study the mechanical and morphological properties of aluminium alloy 7075 by aging treatments

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https://doi.org/10.1016/j.matpr.2024.06.008
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Abstract

The goal of the current research project is to determine the specimen's surface morphology and mechanical characteristics by examining the effects of single and duplex ageing on aluminum 7075 alloy (Al-Zn-Mg-Cu). The age hardening strengthening mechanism is responsible for (Al-Zn-Mg-Cu) alloys. The threesteps of solid solution heating, quenching, and age hardening during theageing process. Five samples are used in the single ageing heat treatment with a dimension of60 mm in length and 25 mm in diameter. The specimens are first heated in a solid solution for one hour at 500 °C, followed by a 30-minute soak of the aluminum alloys in a salt bath. Following that, the specimens are matured for 2, 4, 6, 8, and 12 h at 160 °Ctemperature.. Duplex age-hardening process all five specimens are pre-heat at 160 °C after that double ageing process carried by different time periods same as the single ageing process. After heat-treated aluminum alloy specimens undergo investigation of mechanical properties such as tensile test, hardness test and surface morphology analysis using scanning electron microscopy. The result reveals that the aging process at a temperature of 160 °C for a period of 2h, both the yield strength and tensile strength of the material experienced an increase of approximately 25%

Introduction

Strengthening of aluminium alloy based on age-hardening mechanism. To increase the strength of material methods like solid solution heating, quenching and ageing treatment are carried out. In the processes of quenching and age hardening, although the interior of the grains may exhibit a satisfactory precipitate size and density, the vicinity of effective vacancy sinks, such as grain boundaries, results in the formation of a region devoid of precipitates, commonly referred to as a precipitate-free zone (PFZ). This heterogenous structure is often associated with the aging of the boundary itself and gives rise to suboptimal properties, particularly when subjected to stress corrosion conditions [1], [2], [3], [4], [5]. In order to rectify the problem duplex ageing was performed. It reduced the grain boundary zone and grain size. Perka.et.al [6] studied the precipitation of an Al-Mg-Si alloy after solution annealing at 540°C by TEM. Very small needle-shaped G.P zones were observed on ageing at 200°C. These needle-like precipitates were found to grow in size and increase in density, by prolonged ageing at 220°C. By further ageing, the needle-like shape transforms to rod-shaped with increasing diameter upon ageing at 300°C. Some rod precipitates were found to transform into platelets.

Wang.et.al [9] conducted an investigation into the composition of the G.P zone within the Al-7075 alloy in conditions where aging was not yet complete, employing high-resolution scanning electron microscopy. The morphology of the G.P zone presents itself as a delicate plate with dimensions equivalent to a monolayer in terms of thickness, measuring 2.5nm in width and less than 30nm in length. The G.P zone in Al-Mg2Si alloys is formed through the alternating arrangement of columns consisting of magnesium and silicon atoms along the 〈100〉 direction, with a spacing of 0.405nm. It was observed that Cr and Mn compounds occur in Al-Mg alloys, mainly as compound pinning of the grain and sub-grain boundaries and promote the precipitation of the β phase. In contrast, Zr gives a strong refining action on the primary grains when in solid solution in the Al-matrix [7]. Shwe Wut Hmon Aye (2008) [8] et al described an article representing heat treatment of Aluminium alloys to increase the strength of materials. The project age-hardening mechanism used the strength of material controlled by temperature and time, after the heat treatment microstructure analysis based on the material cooling rate. Age hardening temperatures are 100°C and 200°C values recorded compared to the hardness of materials. The microstructural characteristics of the specimen's (Al-Zn-Cu) architecture were acquired from the rapidly cooled ingot to achieve an equiaxed interconnected framework. This interconnected framework is composed of numerous particles of intermetallic compounds, which are generated through the fusion of alloying elements present in this particular alloy.The view of the sequence of precipitates phases observed during the ageing of the Al-Zn-Mg alloys has been extensively studied. The ageing sequence is currently thought to be supersaturated (α) giving the precipitation of particles in materials (η). The G.P. zones are spherical and have an FCC structure which is fully coherent with the matrix. The microstructure of Al-Zn-Mg alloys after stage ageing treatments has been studied by TEM, with finer precipitate distribution after two-stage ageing [9], [10]. Study of the effects of single ageing, duplex ageing and condition between the first and second step ageing on the microstructure and properties of extrude plate of 7050 aluminium alloy were investigated, utilizing TEM. Al 7075 aged at 120°C can obtain tensile strength of 619 MPa. After ageing with second-step ageing at 165°C can obtain the combination of the tensile strength of 551 MPa [11], [12]. Thermoelectric Power (TEP) was used to study the ageing behaviour of lean duplex stainless steel LDX 2101 during isothermal treatment in the range 400–650°C. In the low-temperature range, the TEP increase was attributed to the precipitation of nitrides. At higher temperatures, the decrease of the TEP was linked to the formation of the chromium-rich phase σ. The complex evolutions of the TEP confirm that these measurements can be very useful for studying the ageing behaviour of lean duplex steels [13], [14].

Section snippets

Materials and method

The aluminium 7075 was supplied in the form of a bar of 25 mm in diameter and 1100 mm in length. The specimen was cut into 10 pieces, and the tensile test specimen piece was cut in 200 mm long [15], [16]. The aluminium 7075 wrought of Al-Zn-Mg-cu alloy with the material composition shown in Table 1. …

Tensile test

Tensile testing will be conducted on specimens subjected to both single ageing and duplex ageing. Tensile examination of the sample substance will be executed in accordance with the ASTM E8 standard employing a test velocity of 5 mm/min utilizing the Universal Testing Machine (UTM). The dimensions of the specimen are provided in Fig. 2, while the apparatus employed for examination is illustrated in Fig. 3.

Fig. 4 displays the tensile properties of the alloys following the age hardening process. …

Conclusion

The Al-Zn-Mg-Cu alloy underwent age hardening at various temperatures. Initially, the Al-Zn-Mg-Cu alloy was subjected to aging at a temperature of 160°C. The maximum hardness of 94.5 RH was achieved after eight hours of aging. Following this, the alloy was further investigated for its aging behavior at a temperature of 180°C. It was found that a maximum hardness of 103.5 RH was attained after a six-hour aging period at 180°C. The STQ treatment involves subjecting the material to solution …

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. …

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