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Study Of Microstructure And Mechanical Properties Of Cast And Forged Al-4.4cu Alloy

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ABSTRACT*:-** *The aim of this paper is to evaluate the effect of hot forging process on the microstructure and tensile properties of as-cast Al–4.4Cu alloy. The secondary process of hot forging was carried out on the alloy samples at a temperature of 450^0C and the load applied is 400 KN . The test results indicates that the mechanical properties was enhanced by the results of hot forging .The improvements in microhardness values are obtained due to the grain refinement and new fine grains induced by forging in Al-4.4Cu alloy.**

Keywords:- *Alloy, hot forging, Temperature, Micro hardness, grain refinement.*

I. INTRODUCTION

Aluminium-alloy forging is currently used to manufacture structural components of relatively large and complex shape. The plastic deformation imparted to the material can positively affect its microstructure by promoting recrystallization cycles and a greater homogeneity of alloying elements.[1] Aluminium alloys with high silicon contents exhibit high strength, low thermal expansion and high wear resistance. These qualities, together with their excellent castability and reduced density, make these alloys very interesting for the automotive industry where they can successfully replace cast iron parts in heavy wear applications[2] Forging of Al alloys are becoming more important in the view of the development in the aviation and transportation industries and hence, it becomes important to study the behavior of the metal which contains second phase particles dispersed in the matrix, when it is plastically deformed. Forging changes the microstructure and mechanical properties both in as cast as well as in grain refined alloys. Recently, the rheological processing of aluminum alloys has quickly developed as an alternative to traditional casting and forging processes driven by the demand for light-weight high performance parts in the automotive industry needed to increase fuel efficiency[3]

An aluminium alloy (Al–7%Si–0.3%Mg, AC4CH) was used in the experiment of forward extrusion. The solidus and liquid us temperatures of the aluminium alloy are 555 and 610 °C, respectively. In the preparation of the initial billets for extrusion, the ingot material was melted in a furnace and coasted to a cylindrical billet of diameter 32 mm. The cast billet was machined to a diameter of 30 mm and length of 30 mm. A servo-hydraulic press with a maximum capacity of 100 KN was used for loading the punch [4] In as-forged composite segregation of particles was largely eliminated and much more uniform particle distribution was obtained by the application of two-steps processing.the yield strength and ultimate tensile strength of Sicp/AZ91 composite were improved obviously. The fracture observation revealed brittle fracture of the composites. [5]. A comparative study on the microstructure and mechanical properties of as cast, cast aged and forged aged A356 alloy has been investigated.Cast aged A356 alloy possesses higher wear resistance compared to as cast and forged aged ones. Forging improves both strength and ductility of alloys over as cast ones [6]

It was observed that during in situ Forging of Al alloys Alloys are becoming more important in the view of the development in the aviation and transportation industries and hence, it becomes important to study the behavior of the metal which contains second phase particles dispersed in the matrix, when it is plastically deformed. Forging changes the microstructure and mechanical properties both in as cast as well as in grain refined alloys. Recently, the rheological processing of aluminum alloys has quickly developed as an alternative to traditional casting and forging processes driven by the demand for light-weight high performance parts in the automotive industry needed to increase fuel efficiency [7] However, no literature appear to exist reporting on the detailed studies on the effect of forging on Al–4.4Cu alloy.

II. EXPERIMENTATION

The primary objective of the present work is to finding the changes of Aluminium - copper alloy when applying hot forging . Al–4.4Cu binary alloy was prepared by diluting Al–33 wt %Cu master alloy with commercial pure Aluminum in a pit type resistance furnace. The Al–4.4Cu alloy was prepared by stir casting route. The molten metal was stirred for 1hr at regular intervals and the molten mixture is poured to the permanent mould. After the solidification process at ambient temperature the specimens are taken out from the mould. Then the Forged specimens was prepared by cast plate heated above recrystallization temperature at 360 ^{0}C and kept at this temperature for 5 min, followed by applied the impact load of 400KN by using mechanical press on the cast specimens . For the plate thickness was reduce to 17mm from 32mm due to 46% reduction for the aluminium copper alloy plates. Then, the plates were cooled at room temperature. The alloy have been characterized by X-ray diffraction. The Specimens for OM was mechanically polished according to conventional method and etched with Keller's reagent for both insitu samples before and after forged. The tensile strength of the composite was measured in an Instron machine.

III. RESULTS AND DISCUSSION

3.1 XRD result for Al-4.4Cu alloy

The X-ray diffraction (XRD) for the prepared Al-4.4Cu specimen are shown in figure 5.2. From the result we can identify that, the higher peak curves indicate the presence of matrix material aluminium. The smaller peak curve indicating the presence of copper in Al-4.4Cu alloy. The peak lists obtained from XRD result for Al-4.4Cu alloy.

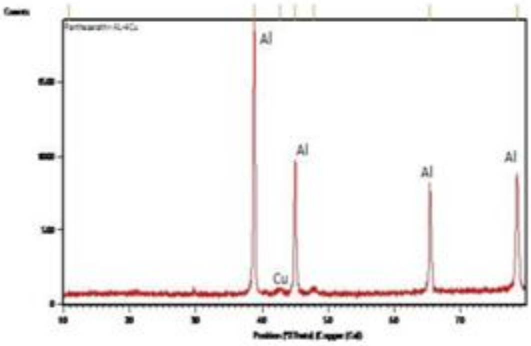


Fig1.XRD pattern of Al–4.4Cu alloy

3.2 Optical Microscope Image

The matrix shows the metal matrix with eutectic of Cu-Al2 in dendrite pattern in aluminium solid solution Fig(2a). The presence of Cu-Al2 grain shows that the material is annealed after casting.After the forging grain orientation of eutectic $CuAl_2$ are along the direction of upsetting. The eutectic particles of $CuAl_2$ are elongated and forms a banding of grains Fig(2b).

Fig.2a Microscopic View of as-cast Al-4.4Cu alloy

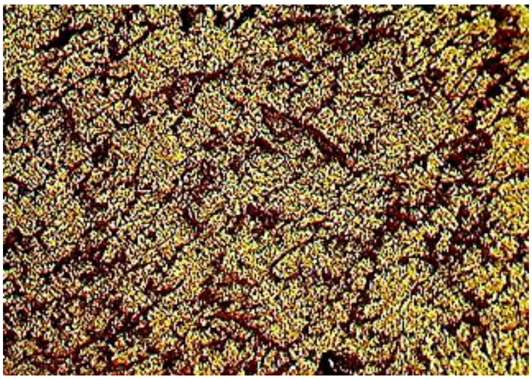
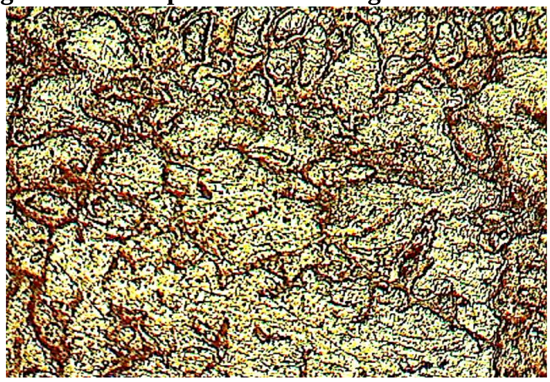
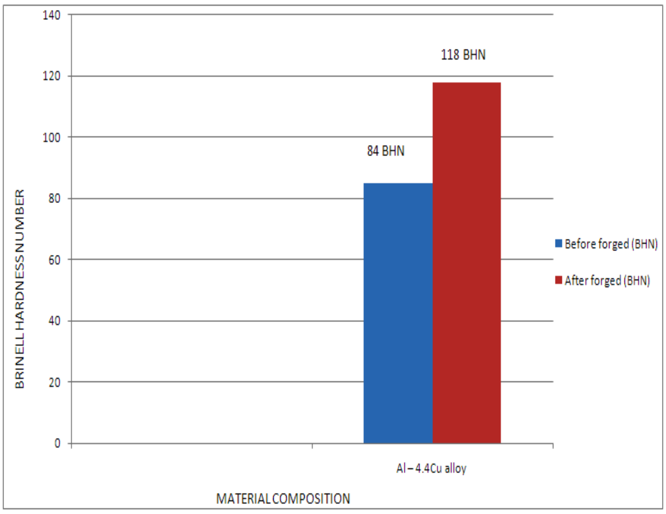


Fig 2b. Microscopic View of as-forged Al-4.4Cu alloy



3.3 Mechanical properties of Al-4.4Cu alloy



Fig(4)The hot forging increases the tensile strength of Al-4.4Cu alloy because of the grain refinement, reduction of the porosity and more homogeneous distribution of the matrix dispersoids . Fig(5)Result of the hot forging the alloy grain size become fine so the hardness also increased.

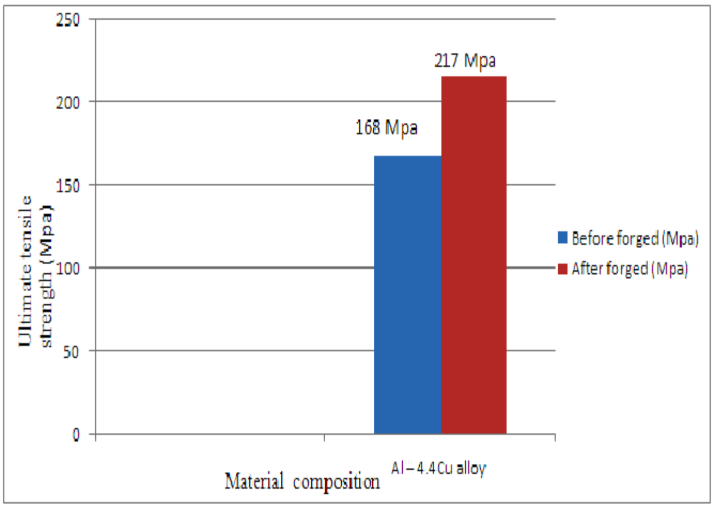


Fig4. Variation of Tensile strength of hot forged and cast Al -4.4Cu alloy

IV. CONCLUSION

Based on this research and discussion above, the following conclusions were obtained

1. The Al-Cu alloy mechanical properties were improved by forging.
2. The micro structural analysis of the forged Al-4Cu alloy indicates that the grain orientation of eutectic $CuAl_2$ are along the direction of upsetting. The eutectic particles of $CuAl_2$ are elongated and forms a banding of grains.
3. These microstructure modifications induced an increase in the tensile strength and elongation to failure of the forged alloy.
4. Improvements in micro hardness values are obtained due to the grain refinement by forging in Al-4.4Cu alloy**.**

REFERENCES

[1]. E. Gariboldi, D. Ripamonti Metallurgical Science and Technology 19 (2003) pp. 143-155.
[2]. S. C. Sharma, "The Sliding wear behavior of Al606-garnet particulate composite", Wear, 249; (2001),1036-1045.
[3]. Y. Wu, L. Zhen, D. Z. Yang, M. S. Kim, S. K. Hwang, Y. Umakoshi, Intermetallics, 12; (2002), 43.
[4]. M. Shiomi, (2003) 'Forming of aluminium alloy at temperaturesjust below meltingpoint' International Journal of Machine Tools & Manufacture Vol.43,pp.229–235.
[5]. R. V. Kurahatti, D. G. Mallapur Influence of Ti, B, and Sr on Microstructure, Mechanical and Tribological Properties of Cast Aged, and Forge Aged A356 Alloy ,International Journal of Machine Tools and Manufacture, 48; Issue 15, December 2008,1626-1636.
[6]. S.C. Tjong, K.C. Lau, Properties and abrasive wear of TiB2/Al–4%Cu composites produced by hot isostatic
pressing, Comp. Sci. Tech. 59 (1999) 2005–2013