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Plastic deformation characteristics of sap type alloys

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ABSTRACT

Grain refinement is well known to influence the mechanical properties of materials, especially the strength characteristics. The promising and excellent method for grain refinement is a high plastic deformation process and it produces the homogeneous nano grain material which exhibits very high strength and limited ductility. Sintering is a complex process for heating powder metal because the final properties of the P/M parts are direct functions of the heating environment. Hence sintering process is carefully monitored to get outstanding mechanical properties. This paper explains the study of tensile specimen after its sintering, compaction and extrusion characteristics and process.

KEYWORDS

Plasticity;
Deformation;
Stress;
Strain and tensile test.

INTRODUCTION

Aluminium and its alloys

The most important property of aluminum is its low specific gravity 2.7, high electrical and thermal conductivities, high ductility and corrosion resistance in various media. Widely used aluminum alloys in industry are wrought alloys from which a great variety of articles are made by means of rolling, forming, drawing, forging etc. When aluminum is alloyed with copper, nickel, iron, silicon they improve the strength properties of the alloys and enable heat treatment to be applied.

EXPERIMENT

Tensile specimen is prepared for the Alloy Composition of 7 % copper in aluminum powder. 930 gm of Al powder is mixed with oxidized copper of 70 gms. The mixture is compacted at a pressure of 18 tonnes using Hydraulic Press and 15 compacts are prepared. The lubricant used during compaction for smooth flow is Molybdenum disulphide. The slew rate of the powder composition, theoretical density, apparent density, compaction ratio, compressibility plot, the percentage of porosity studied for the above combination. The compacts are coated with Zinc stearate and they are sintered in Muffle Furnace at a temperature of 550°C. The compacts are extruded using die diameter of 6 mm, 8 mm and 12 mm at different temperatures 350°C and

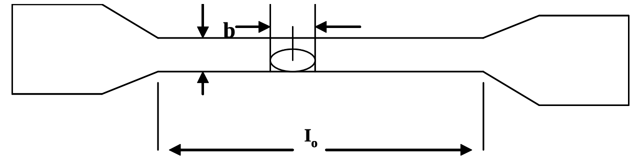

Figure 1 : Tensile specimen

450°C. The extruded part is well polished and numbers of tensile specimens are prepared for tensile test. The prepared tensile specimens subjected to tensile test using tenso meter.

The process of tensile test for a particular specimen (Figure 1) is studied and discussed in the following paragraph.

Principal dimensions: h=thickness b=width l_o=gauge length of the rectangular specimen

Standard specimens[1] of rectangular cross section are used for tension test. Standard test specimens have a cross sectional area of 314 sq. mm (d =20 mm). The cross sectional area of standard specimen is selected arbitrarily, but the gauge length should satisfy the following conditions L_o =5.65 v F_o where F_o is the initial cross sectional area of the specimen in sq.mm.

In a tension test the rectangular specimen is deformed by the action of a smoothly increasing load up to the point of rupture. During the tensile tests readings are made to obtain data for plotting a tension test diagram. Such a diagram shows the relation between the forces applied[2] to the specimen and its resulting deformation (Figure 2).

On the tensile diagram (Figure 3), the values of the applied load P are plotted as ordinates and the absolute elongation ? L (Deformation) corresponding to each load is plotted as an abscissa.

On section OP_p of the curve the elongation ?L of the specimen is directly proportional to the load. This relation agrees with the law of proportionality which states that variation in the load applied to the specimen will lead to a proportionality variation in the strain. Nearly 15 specimens of the AL-CU composition of 930-70 gm prepared and almost all the 14 specimens showed improved plasticity and one specimen showed abnormal behavior. Hence the special attention is given on the characteristics of that particular specimen. The load P at which a straight line relation is still observed between load elongations is called the proportional load limit.

The proportional limit σ_p is the maximum stress at which the relative elongation remains directly proportional to the load $\sigma_p = P_p / F_o$ kgm/sq. mm. = 120 kgm/sq. mm.

The load P_e at which the permanent set of the specimen is equal to 0.5 % of its initial gauge length is called the elastic limit load. The load P_e is very near in value to the load P_p.$\sigma_e = P_e / F_o$ kg per sq.mm and it is equal to 125 kgm/sq.mm

Above point P_e the tension curve deviates considerably from straight line and at a load corresponding to P_s goes over into a horizontal section. In this region the material of the specimen receives considerable permanent set without an increase in the applied tensile load i.e. the specimen seems to cease offering resistance to the tensile forces therefore it flows. The load P_s at which the material begins to flow is called the yield point load and the horizontal part of the curve where the specimen elongates without increasing the load is called the yield step. The yield point σ_s is the minimum stress at which specimen is deformed without a noticeable increase in load $\sigma_{s=} P_s / F_o$ Kg per sq mm and it is equal to 196.87 Kg/Sq mm

Beyond the yield step the load can be increased again to a certain maximum value P_b where a localized reduction of cross sectional area or necking down occurs[3]. This construction of area at the neck leads to drop in the load, and at point P_z the specimen is ruptured (Figure 4).

The maximum load P_b after which necking down

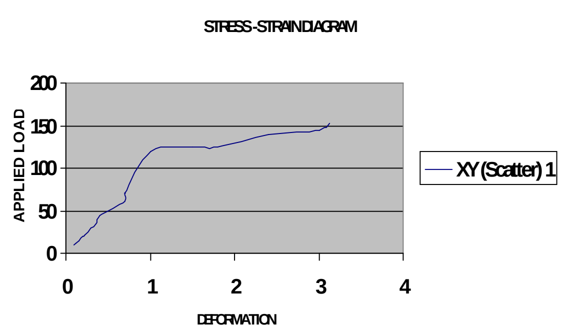

Figure 2 : Stress –Strain diagram

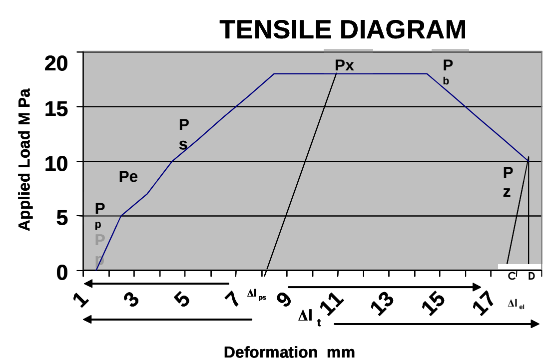

Figure 3 : Tensile diagram

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Figure 4 : Ruptured tensile specimen

begins is called the tensile strength load. The tensile or ultimate strength is the stress corresponding to the maximum load reduced before rupturing the specimen.$\sigma_{b=}P_b/F_o$ Kg per sq mm and it is equal to 152.84 Kg/Sq mm.

The total strain (deformation) ΔL_t, (elastic and permanent at the moment of fracture) is equal to the distance OD ΔL_t = 3.13 mm. To obtain the separate values of the elastic strain and the permanent set at the moment of fracture it is necessary to draw a straight line[4] on the tension diagram from point P_z to the axis parallel to the straight line section of the load strain curve. The line OC represents the amount of permanent set ΔL_{lps} and the line CD the total elastic strain. Relative reduction in area is the ratio of the maximum reduction in cross sectional area of the specimen after rupture to the initial area expressed in %.

$\Psi = F_o - F_r/(F_o) = 1.77/14.65 = 12.08\ \%$

RESULTS

Number of Tensile specimens is prepared and one sample is taken for investigation and the corresponding dimensional specification of one specimen is shown in the following table (TABLE 1). Degree of deformation and percentage of reduction area showing the increase in strength of mechanical properties of 7% Cu in Aluminum. The present experimental investigation showed that it is possible to make powder metallurgy components from different composition of Al -Cu.

TABLE 1 : Dimensional specification of tensile specimen

Specifications	Values
Gauge length L o	15.81 mm
Original diameter of specimen D 20	4.32 mm
Final Diameter of specimen D 21	4.05 mm
Length of the fracture L f	18.94 mm
Original area of cross section Ao =F o	14.65 mm2
Reduced area of cross section A r = Fr	12.88 mm2
ΔL=Lf - Lo	3.13 mm
e = ΔL / Lo	.1979
d 02 - d o2 / d 2o	.1190
Yield Load	196.87
Maximum Load UTL	196.87
UTS = UTL/(A0 +Af)/ 2	152.84
Degree of deformation φ= log A0/ A1	Log 1.1374
% Reduction of area	87.91

CONCLUSION

Metals and alloys of different nature do not have the same ductility[5] and therefore; behave differently when subjected to hot and cold working. It has been established that the plasticity of a metal depends upon its chemical composition, structure, heating temperature, rate and degree of deformation[6]. It is a fact that pure metals have a higher plasticity than their alloys. Pure copper is many times more plastic than its alloys with tin etc. The rate of deformation in mechanical working affects the plasticity of the metal in various ways. An increase in the deformation rate with in a definition limit is accompanied by a decrease in plasticity[7]. The type of stressed state and the type of deformation also affect the ductility of the metal in the course of a mechanical working operation.

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REFERENCES

[1] F.Nia, B.L.Davis; Powder Metallurgy, **25**, 209-213 **(1982)**.
[2] S.K.Hajra Chouldry; 'Materials Science and Processes', Indian Book Distributing Company, India, Chapter 8, 147 **(2008)**.
[3] H.Raymond Higgins; 'Engineering Metallurgy- Part II', Hodder and Stoughton Ltd., Toronto, 211 **(1976)**.
[4] A.H.Cottrell; 'Theoretical Structural Metallurgy', The English Language Book Society, 93 **(1983)**.
[5] R.Z.Valiev, R.K.Islamgaliev, I.V.Alexandria; 'Progressive Metallurgy Science', **45**, 103-189 **(2000)**.
[6] I.V.Alexandrov, R.Z.Valiev; Scripta Mater., **44**, 1605-1608 **(2001)**.
[7] Zuhailawati Husain, Koay Han Keong; Journal Teknologi., **43**, 1-10 **(2005)**.