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Thermal Treatment and ECA Pressing Processed Ultra-Fine Grain AI Alloys: Structure and Properties

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Abstract: The structure and characteristics of aluminum-base sub-grade alloys with cereals micro-structure susceptible to severe plastic deformations (ECA pressing). Before and after the ECA pressure therapy, the structures and the characteristics of alloys 7050 and 2224 have been investigated in detail. With a fault elongation of 15 percent, the ultimate tensile power for the 7050 alloy was 677 MPa, whereas the 2224 alloy showed 618MPal with a fault elongation of 12 percent. Direct screening and recrystallization of bands in specific strains and rinsing systems resulted in finer cereal growth under the pressure of ECA. All improvements to grain refinement, dislocation reinforcement and precipitation were discussed in this Article more evenly and finely than the conventional T6 alloy. The development of fine grains has two explanations. One is that the ground grain is directly cut into fine grain with low angle limits by different bands. A further explanation is the development of high-angle recrystallized grains.
Keywords: Ultimate Tensile Strength (UTS), ultra-finite-grains (UFGs), Transmission Electron Microscope (TEM),fault elongation, Recrystallized.

I. INTRODUCTION

Allows us to modify the alloy composition or employ various grain reinforcement elements for the development of the fine microstructure needed for optimum features in demanding applications (1, 5). The Al-Zn-Mg-Ku and Al-Cu-Mg aerospace alloys are very commonly used. Fine microstructures may also be systemically created by severe deformations like soldering, banding [6], compression twisting [7], and reciprocal extrusion [8]. Since the sample cross sections can create UFGs (ultra-finite-grains) without modifying them and leading to fine cross-grained samples (2–10 nm), in completely dense environments the lateral equivalent pressure is promoted at the present moment. The grain refinement is typically followed by an ECA pressing dislocation that gives more specimen strength and numerous strong alloys have shown similar phenomena, leading in large increases in the ageing hardness while heat is being treated. They chose to evaluate the microstructure, traction strength and ductility of thermal process alloys and determine whether they had synergy between the two therapies.There were some slip bands in method 2 that were not removed during ageing. This formed the microstructure, which included slip strips of less than one micrometer in diameter in ultra-fine grains. In the short anneal routes A and C, not all dislocations and fiber flaws were avoided. In the case of Route BC, however, the observed incursions into the 900 rotation favor equalized grain production very much.A microscopy was done with a JEOL2000 TEM 160 kV. The linear intercept approach directly used the TEM photomicrographs created measurements of the grain size. Abbreviation used for room temperature - rmThe network of entices is progressively developing into sub-grain barriers as the number of stresses increases. As the plastics strain rises, the sub grains become more disorientated and sharper in relation to their surroundings.

II. METHODOLOGY

The aluminum alloys 7050 and 2224 (wt. percent) are presented in Table 1. Table 1. The internal angle of the ECA pressing facility was = 120o and an extra angle of = 60o in the curvature outer arc, where both channels cross. For ECAs with 8 mm diameters and 55 mm long, the samples were machined. The ECA pressing was performed under 3 distinct circumstances in samples of the 7050 and 2224 alloys:

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1) Method 1: rinsing before ECA pressing and pressing after ECA brief rinsing therapy and ageing
2) Method 2: short rinse after ECA rinsing, then additional ECA rinsing and ageing before ECA rinsing.
3) Method 3: water quenching processing, ECA pressing and ageing followed.

Table: 1 Alloys 7050 and 2224 Chemical Composition

Al	Si	Fe	Cr	Mn	Ti	Zr	Mg	Cu	Zn	Alloy
Balance	0.07	0.065	-	0.57	-	-	1.47	4.15	-	2224
Balance	<0.05	<0.12	<0.04	<0.1	0.045	0.08	1.91	2.14	6.09	7050

Table 2 provides a summary of the entire specifics of these processes. The short 0,5-hour rinse treatment at 743 K was found sufficient to minimize internal stress and avoid precipitation and grain coursing.

Table: 2 Alloys 7050 and 2224 Detailed Processing Procedures

2 ECA passes at rm, aged in the air for eight days, were treated at 763K for 0.5h.	Method 3	Alloy 2224
1 to 4 ECA passes were renewed for 1h at 683K, renewed for 0.5h at 763K, aged for eight days in air.	Method 1	
1 to 4 ECA passe at ambient temperature, annealed at 763K for 0.5h, repeated at 683K for 1h, 2 ECA passes aged in air for eight days	Method 2	
2 ECA passes at 393K, aged 393K at 16h, treated at 743K for 0.5h	Method 3	Alloy 7050
At 553K for a period of 5 hours, 1 to 4 ECA passes were carried out at room temperature, 743K for 0.5 h, 393K for a period of 24 hours	Method 1	
Removal of 2 ECA passes at a temperature of 1 to 4 ECA, ringing with 553K for 5h, annealing at 743K, repeatedly at 0.5h and ageing at 393K for 24 hours	Method 2	

A. ECA-pressed Microstructures

Figure 1 shows the original microstructure of 7050 alloys. (The figure in Table 1b and c) Even after 05 hour of rinsing at 743°C, the alloy particles did not increase by one millimeter. After short rinsing, some of the complete substrate interior was not sufficient and hardened by grain (Fig. 1). Method 3 generates the structure of the average size of the grain after five compression cycles with the elongation of shear belts is 7050 nanometers. Since the extrusion is short rinsed.

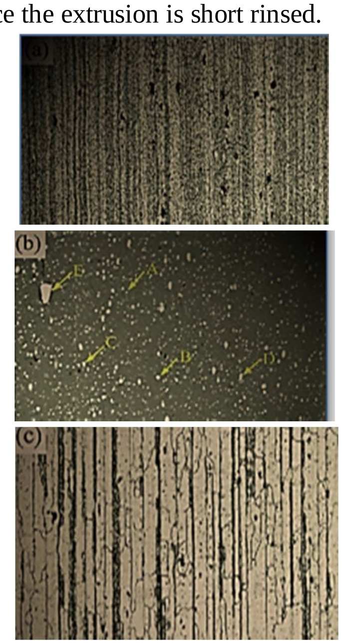

Fig 1. Microstructure of Alloy 7050

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B. After ECA Pressing, Mechanical Characteristics

As a consequence of TEM data, different pressing paths were checked. However, differing pressing paths influenced the mechanical properties of the samples in 3 stages. Figure 2 and Figure 3 indicate the difference in the number of presses utilizing the Route BC. A UTS of 490MPa, YS of 324 MPa, and an extension of 29% for the 2224 alloyed sample produced in the three steps of procedure 1 ECA pressing. In the rinsed sampling, just two EAC pressure were applied to the YS and UTS readings of 582 and 618 MPa and an extension of 12%. As 7050 alloys are frequently used for artificial ageing, 7050 samples of tapered samples are pushed through at ageing temperature (Method 3). UTS and YS were generated for 16 hours in the ensuing ageing phase using three ECA presses of 677 and 667 MPa, respectively, at 393 K. They are 150 MPa larger than the standard 7050 alloy the next item is: (520 MPa). The 15% extension for failure was at the same time equal to the normal 7050 alloy (14 percent).

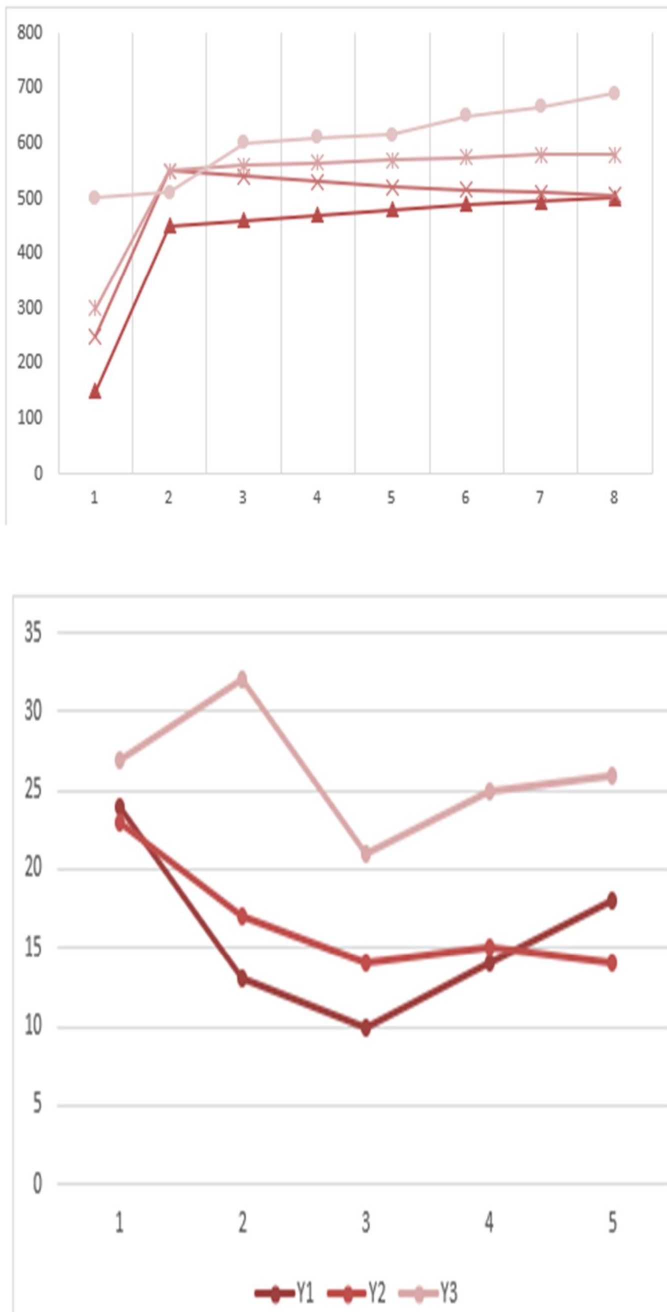

Figure:2 (a) UTS and YS variations, (b) Failure elongation variation

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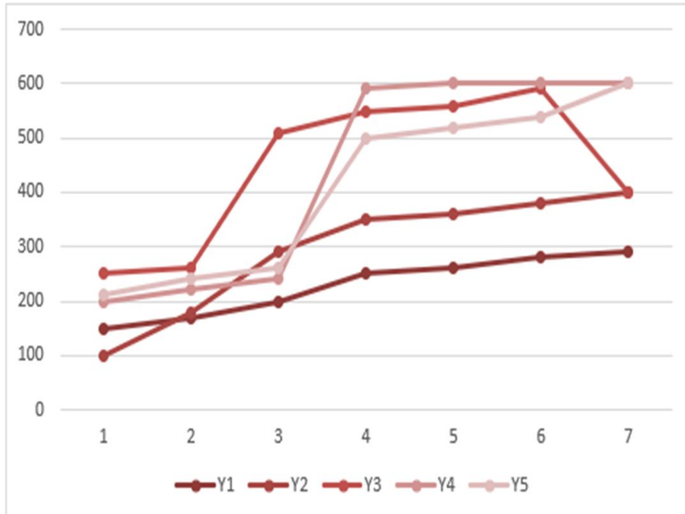

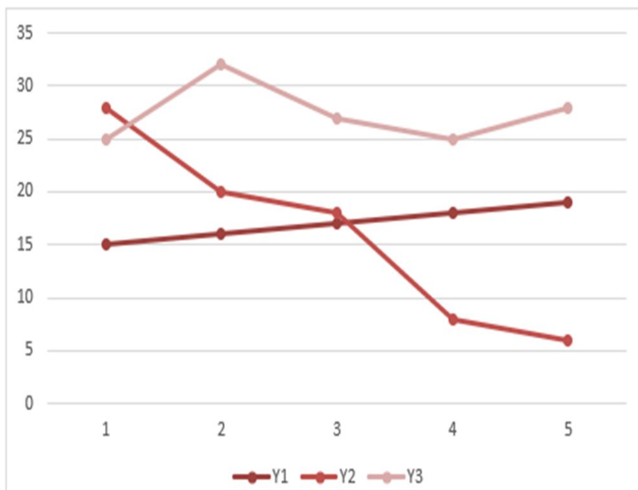

Figure:3 (a) UTS and YS variations, and (b) fault elongation variations

The 2224 alloy sample UTS was at room temperature about after two stages of ECA pressure. The extension was about 545 MPa and YS 511 MPa. The alloy is a super-high-power alloy with a YS of above 500 MPa according to Chen. In this case the ECA pressing and proper heat treatment have acquired the extraordinarily high strengths of the 7050 and 2224. Kim et al. also showed a 40 per cent improvement in UTS and YS in combination with post ECA Al 6061 pressing ageing therapy with the use of pre-ECA solid solution therapy.

III. DISCUSSION

A. *Enhancement of Grain Fineness*

Fig.2a shows that the extended grains are broken into fine equalized grains at the intersection of the bands. When examining materials generated by ECA pressure and thermal treatment in SAED patterns, some diffractive spots show that misdirection across grain frontiers increases as strain increases [18]. InFirst Method a brief anneal was used for the solution temperature to reduce internal stress, to prevent fine grain coarsening and to strengthen precipitation in following age therapy. InSecond Method, the samples after the four pressures were fragile and easy to break with the subsequent pressing because to the high internal stresses caused by ECA pushing. Therefore, for repeated pressing, the brief anneals followed by an ECA push is essential. InThird Method, the soaked samples at the ageing temperature are distorted. The strength of the samples is raised when grain is refined. Meanwhile, lowering the size of the grain also represents a highly efficient way to prevent early fracture nucleation from arising from a stress location [27].

B. Enhancement of Precipitation

After three ECA pressing runs (age: 16 h at 393 K), the microstructure of 7050 is different from traditional T6-treated 7050. The precipitation distribution is not consistent. SAXS is one of the most powerful ways of investigating the influence of ECA pressing on the microstructures of alloys for the investigation of nanosized precipitation in a bulk spectrum:

$$\boldsymbol{I(h) \propto \exp(-h^2R^2/3)}$$

Were,
I(h)=scattering intensity
λ= X-ray wavelength
2θ= scattering angle
h=2πsin(2θ)/λ
and
R = gyration radius

The gyration radius can be calculated through the slope α of the Guinier curve ($R = \sqrt{-3\alpha}$), and the effective radius of spherical particles is √(5/3) of the gyration radius. Fig. 6 shows the Guinier plot (ln(I) vs. h^2) for alloy 7050 after two different treatments. Thus, the precipitate size, consistent with the TEM observations, became finer with ECA pressing.

C. Reinforcement of Dislocation in High Density

The capability of repeated extrusions is a benefit of ECA pressing, such that the same stress may be accumulated via a die at each stage. However, distorted samples were quickly rinsed after the ECA pressurization in the current research, therefore some dislocations were rinsed. So, it is not possible to simply accumulate the ultimate equivalent pressure on the samples. Following a two-pass ECA pressing, Fig. 4is micrograph of the sample sampled alloy 2224. Dislocation networks occur during shaving, which enhances sample strength since moving dislocations have to pass through densely populated zones.

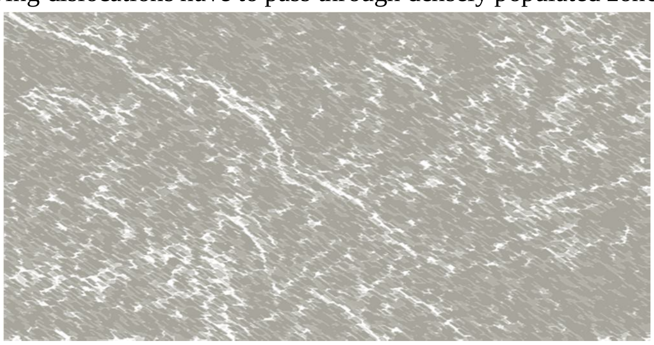

Figure:4 T6-treated sample

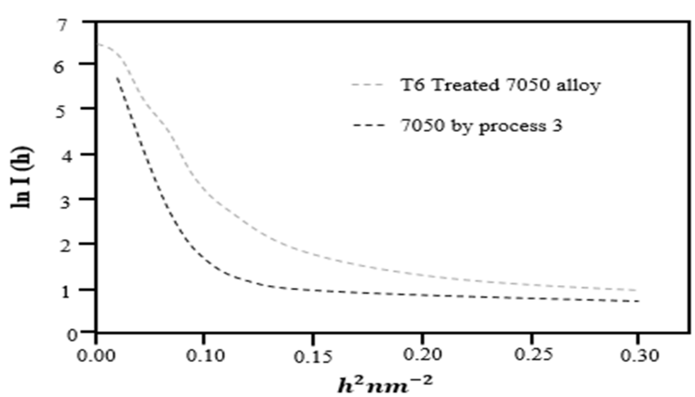

Figure:5Alloy 7050 Guinier plot (ln(I) vs. h^2)

Figure: 6 Samples of 2224 alloy micrograph

IV. CONCLUSION

To boost strength and ductility, we provide the efficient ECA press schedule in conjunction with heat processing of aluminum alloys. A UTS of 677 MPa with a fault extension of 15 percent may be achieved using alloy 7050. A 618 MPa UTS may be achieved by alloy 2224 with an extension of up to 12 percent failure. ECA pressure with ageing temperature has been reinforced to minimize the ageing duration to 16 h by increasing the dynamics of the 7050 alloy.The enhancement of mechanical characteristics of alloys 7050 and 2224 was supported by 3 strengthening techniques. They were strengthened by grains of sub micrometer size, strengthened by their high density of dislocation due to ECA pressing. The creation of finer, more homogeneous precipitates than could be achieved following deformation and solution treatment with standard T6 treatment was strengthened by the ECA.

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