# EFFECTS OF INITIAL MICROSTRUCTURE ON THE DEVELOPMENT OF MICROSTRUCTURE AND MECHANICAL PROPERTIES IN ENERGY SAVING AZ31 MAGNESIUM ALLOY DURING HOT ROLLING

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## Introduction

As the lightest metal, magnesium alloy is attracting more and more interests, and widely used in the aviation, automotive and electrical industries. But magnesium wrought alloys are drawing a lot of attention and have been extensively studied. The major obstacle to the practical application of the alloys is the poor formability at room temperature, originating basically from the insufficient number of slip system in HCP crystal structure. Development of a proper microstructure and/or texture, addition of miner element such as Li, is the promising solution to improve the formability. In the present work, after extrusion and full annealing, rolling at 300℃ with different starting textures, the microstructures, texture developments and tensile properties of AZ31 Mg alloys are studied.

## Experimental

The material used in this work is an extruded commercial AZ31 Mg alloy (Mg-2.89wt.%Al-0.96wt.%Zn) with a diameter of 50mm. The rod was full homogenized at 400℃. For rolling the rod was cut with a plate of 3mm thickness in extruded direction as shown in Fig.1. The plates were rolled up to 60% reduction in thickness for extruded direction (LS sample) and vertical to the extruded direction (TS sample) at 300℃. The thickness reduction per pass was about 10%. Microstructure and texture development during rolling were observed.

For texture analysis six {10.0}, {00.2}, {10.1}, {10.2}, {11.0}, {10.3} incomplete pole figures were measured with XRD (Bruker-AXS D5005 model), and the ODF (orientation distribution function) was calculated by the harmonic method.

In order to evaluate the affect of developed texture and microstructure which reaches in mechanical properties accomplished a tension test. The samples for the tensile test were cut out in rolling direction, 45° to the rolling direction, and 90° to the rolling direction from the 60% rolled sheet. And analyzed the change of the yield strength, tensile strength and elongation whom follows in sample directions

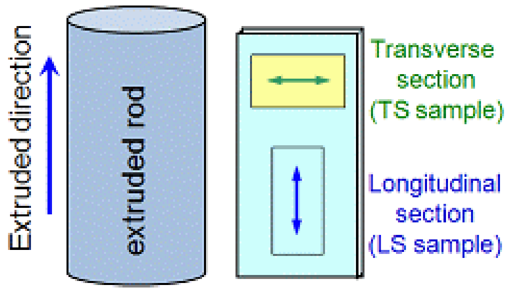


Fig. 1. Samples for rolling, sheets are cut out with a 3mm thickness in a longitudinal section (LS) and transverse section (TS) to the extrusion direction (arrows indicate the rolling direction of sheets)

## Results and discussion

**Microstructure:** Fig. 2 shows the microstructure of the full annealed rod which was hold 8 hrs at 400℃ after extrusion. The microstructure can be described as an inhomogeneous developed microstructure with small and large grains, and elongated grain extends with extrusion direction.

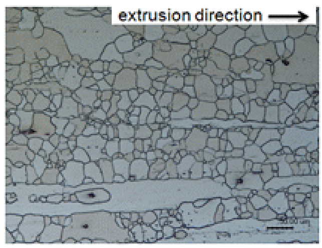


Fig. 2. Microstructure for the longitudinal section of the extruded rod, after full annealing treatment

Fig. 3 shows the microstructure of TS and LS sample, which were rolled up to 60% at 300℃. After 10% rolling most grains still remain the initial form, but lots deformed twins are created. After 30% rolling, twins are observed so far and many dynamic recrystallized small grains are formed. According to rolling degree the area of dynamic recrystallization is extended. It is well known that the dynamic recrystallization is occurred when the Mg alloys are rolled at above 300℃. After 60% rolling the mean grain size of TS and LS sample are 9.54 and 6.25㎛ respectively. In case of TS sample, the average grain size is larger and the distribution of grain size is wider than those of LS sample.

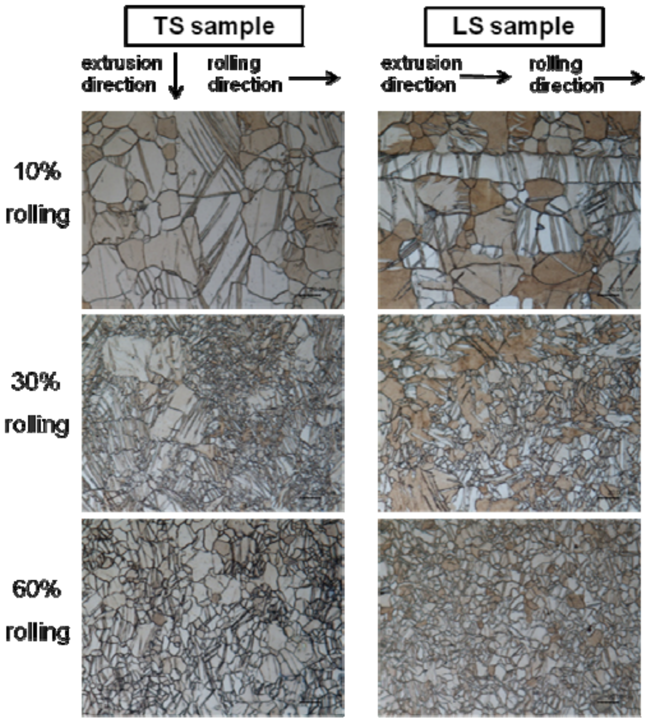


Fig. 3. Microstructure of 10% and 60% rolled TS and LS sample at 300℃

**Texture:** After 60% rolling, the analyzed {00.2} pole figures of TS and LS sample were presented in Fig.4. In both samples, relatively strong <00.1> ∥ ND fiber texture is developed. The basal poles are split and rotated towards the rolling direction about 5° for TS sample and about 2° for LS sample

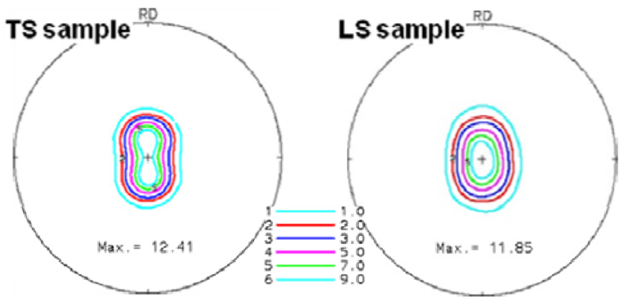


Fig. 4. {00.2} pole figure representing the texture of AZ31 after 60% rolled TS and LS sample at 300℃

**Mechanical Properties:** In Fig. 5. σ-ε curves for rolling direction (RD), 45° to RD, and 90° to RD of the 60% rolled TS and LS sample are presented.
Results indicate that the tensile properties depend on the microstructure and direction of the specimen. In case of TS sample, low tensile strength and elongation show in the rolling direction, but in the transverse direction show the higher value. In case of LS sample, the tensile strength and elongation are relatively similar regardless of the direction of the specimen. This phenomenon is considered to be due to the texture and microstructure which were developed during rolling at 300℃.

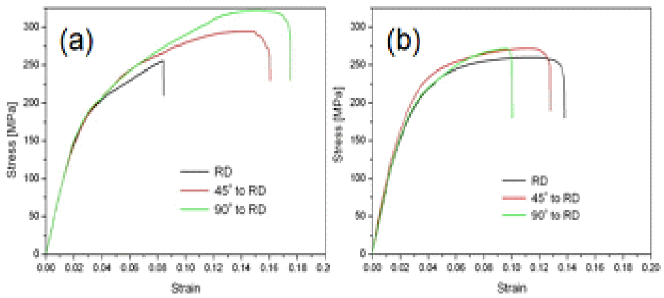


Fig. 5. σ-ε curve for RD, 45° to RD, and 90° to RD, 60% rolled TS sample (a) and LS sample (b)

## Conclusion

The microstructures, textures and tensile properties of AZ31 Mg alloys after 60% rolling at 300℃ depend on the initial microstructure. In case of TS sample (rolled in vertical to the extrusion direction), the average grain size is larger and distribution of grain size is wider than those of LS sample (rolled in parallel to the extrusion direction). The basal poles of the TS sample are split and rotated towards the rolling direction about 5°. Tensile properties of the TS sample are very irregular depending on the sample direction.

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