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Investigation on the Effect of Titanium (Ti) Plus Boron (B) Addition to the Mg-AZ31 Alloy in the as Cast and After Extrusion on Its Metallurgical and Mechanical Characteristics

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Abstract : Magnesium - aluminum alloys are versatile materials which are used in manufacturing a number of engineering and industrial parts in the automobile and aircraft industries due to their strength – to –weight -ratio. Against these preferable characteristics, magnesium is difficult to deform at room temperature therefore it is alloyed with other elements mainly Aluminum and Zinc to add some required properties particularly for their high strength - to -weight ratio. Mg and its alloys oxidize rapidly therefore care should be taken during melting or machining them; but they are not fire hazardous. Grain refinement is an important technology to improve the mechanical properties and the micro structure uniformity of the alloys. Grain refinement has been introduced in early fifties; when Cibula showed that the presence of Ti, and Ti+ B, produced a great refining effect in Al. since then it became an industrial practice to grain refine Al. Most of the published work on grain refinement was directed toward grain refining Al and Zinc alloys; however, the effect of the addition of rare earth material on the grain size or the mechanical behavior of Mg alloys has not been previously investigated. This forms the main objective of the research work; where, the effect of Ti addition on the grain size, mechanical behavior, ductility, and the extrusion force & energy consumed in forward extrusion of Mg-AZ31 alloy is investigated and discussed in two conditions, first in the as cast condition and the second after extrusion. It was found that addition of Ti to Mg- AZ31 alloy has resulted in reduction of its grain size by 14%; the reduction in grain size after extrusion was much higher. However the increase in Vicker's hardness was 3% after the addition of Ti in the as cast condition, and higher values for Vicker's hardness were achieved after extrusion. Furthermore, an increase in the strength coefficient by 36% was achieved with the addition of Ti to Mg-AZ31 alloy in the as cast condition. Similarly, the work hardening index was also increased indicating an enhancement of the ductility and formability. As for the extrusion process, it was found that the force and energy required for the extrusion were both reduced by 57% and 59% with the addition of Ti.

Keywords : cast condition, direct extrusion, ductility, MgAZ31 alloy, super - plasticity
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