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Effect of Zirconium (Zr) Amount on Mechanical and Metallurgical Behavior of ZE41A Magnesium Alloy

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Abstract : ZE41A magnesium alloy has been extensively used in aerospace industry, especially for use in rotorcraft transmission casings. Due to the improved mechanical properties, the latest generation of magnesium casting alloy EV31A-T6 (Elektron 21® specified in AMS 4429) is seen as a potential replacement for ZE41A in terms of strength. Therefore, the necessity of enhancement has been arisen for ZE41A in order to avoid fully replacement. The main element affecting the strength of ZE41A is Zirconium (Zr), which acts as a grain refiner. The specified range of Zr element for ZE41A alloy is between 0.4 wt % and 1.0 wt % (unless otherwise stated by weight percentage after this point) as stated in AMS 4439. This paper investigates the effects of Zr amount on tensile and metallurgical properties of ZE41A magnesium alloy. The Zr alloying amount for the research has been chosen as 0.5 % and 1 %, which are standard amounts in a commercial alloy (average of 0.4-0.6%) and maximum percent in the standard, separately. 1 % Zr amount has been achieved via Zirmax (66.7 Mg-33.3 Zr) master alloy addition. The ultimate tensile strength of ZE41A with 1% Zr has been increased up to about 220-225 MPa in comparison to 200 MPa given in AMS 4439. The reason for the increase in strength with the addition of Zirmax is based on the decrease in grain size, which was measured about 30 µm. Optical microscope, scanning electron microscopy (SEM) and X-ray Diffraction (XRD) were used to detect the change in the microstructural futures via alloying. The zirconium rich coring at the center of the grains was observed in addition to the grain boundary intermetallic phases and bulk Mg-rich matrix. The solidification characteristics were also identified by using the cooling curve obtained from the sand casting mold during cooling of the alloys.

Keywords : aerospace, grain refinement, magnesium, sand casting, ZE41A
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