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Corrosion and Wear Resistance of Zn-Al Alloys with Columnar, Equiaxed and Columnar-to-Equiaxed Transition Structures

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Abstract – The columnar to equiaxed transition (CET) has been examined in different wrought and casting alloys for many years and the metallurgical significance of CET has been treated in several articles. Experimental observations in the literature have focused on thermal parameters like cooling rate, velocity of the liquidus and solidus fronts, local solidification time, temperature gradients and recalescence.

The objective of the present research consist on studying the influence of the type of structure (columnar, equiaxial or the CET) in Zn-Al alloys (Zn-1%Al to Zn-4wt%Al, weight percent) on the corrosion and wear resistance. The results show that the CET zone and the equiaxed structures presented a better corrosion and wear resistance than the columnar zone.

It is necessary to study in systematic form the relation between the structural parameters and corrosion and wear resistance. Zinc cast alloys can be used for general industrial applications where strength, hardness, wear resistance or good pressure tightness are required. Zinc alloys often are employed to replace cast iron because of their similar properties and higher machinability ratings [1].

Zinc-Aluminum (ZA) alloys of different compositions (Zn-1%Al to Zn-4wt%Al, weight percent) were prepared from Zinc (99.998%) and Aluminum (99.960%). The alloy samples were melted and solidified directionally upwards in an experimental set up described elsewhere [2] in order to obtain different structures (Figure 1(a)).

For the electrochemical tests (Figure 1(b)) samples of 2 cm in length of each zone (columnar, equiaxed and CET) and for each concentration, were prepared as working electrodes cutting from the longitudinal sections, polished with sandpaper (from CSi #200 until #1200) and washed with desmineralized water and dried by natural flow of air. All the electrochemical tests were conducted in 3%NaCl solution at room temperature using an IM6d ZAHNERs electrik potentiostat coupled to a frequency analyzer system, a glass corrosion cell kit with a platinum counter electrode and a sutured calomel reference electrode (SCE). Polarization curves were obtained using a scanning rate in the range of $0.002V/s \leq v \leq 0.250V/s$ from open circuit potential until to 0.250V. Impedance spectrums were registered in the frequency range of 10^{-3} Hz ≤ f ≤ 10^{5}Hz in open circuit.

The wear tests (Figure 1 c)) were performed in a pin-on-ring machine, consisting of a grey cast iron disc of 272 HB in hardness and 170 mm in diameter, which rotate giving a tangential velocity of 2.7 $m.s^{-1}$; the sample pin slide on the periphery. All the experiments were performed at room temperature and the ambient moisture ranged from 60 to 75 %HR.

The results show that the CET zone and the equiaxed structures presented a better corrosion and wear resistance than the columnar zone.

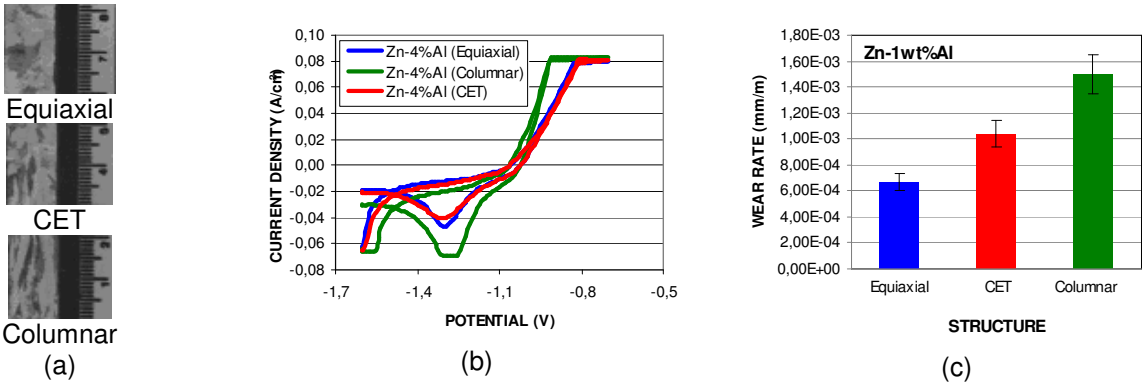

Figure 1: **(a)** Representatives macrostructures of columnar, CET and equiaxial zones. **(b)** Polarization curves for each structure. **(c)** Wear rate vs. structure.

References

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[2] A.E. Ares, C.E. Schvezov, Metall. Mater. Trans. 38 (2007) 1485-1499.