INFLUENCE OF ALLOYING ELEMENTS ON THE MICROSTRUCTURE AND ELECTROCHEMICAL BEHAVIOUR OF CAST AL-ZN SACRIFICIAL ANODES

S. EL-HADAD, M. E. MOUSSA, M. WALY
Department of Casting Technology Central Metallurgical
Research and Development Institute
Helwan, Egypt

Introduction

Aluminium is known as an ideal material for sacrificial anodes used for cathodic protection in sea water. This is due to its low density and high current capacity (2980 Ah/kg) on one side and its low price on the other side. Aluminium is typically alloyed with other elements to encourage the breakdown of the oxide film and move the operating potential of the metal towards a more electronegative direction. These alloying additives are known as modifiers and depassivators. Elements as zinc, magnesium, barium and cadmium are considered modifiers, while indium, mercury and tin are used as depassivators [1]. In the current study, the influence of adding Sn and Mg on the microstructure and electrochemical properties of the Al – 5 wt. % Zn anode alloy was investigated.

Experimental work

Ingots of high purity Al and pure Zn were cut for melting. Afterwards, the charge of about 1,5 kg of each alloy was melted in a graphite crucible placed in an electric resistance furnace. The base composition of the investigated alloy was Al-5 wt. % Zn. Tin was added in amounts of (0,1…1,0) wt. % to produce modifications of the base alloy with Sn and magnesium was added with (0,5…2,0) wt. % to make another set of alloys based on Mg. Manual stirring was applied using a stainless steel rod for homogenization of the additives. The cast samples were sectioned transversely at 20 mm above the bottom of each casting and prepared for microstructure examination. A potentiostat was used for all the electrochemical measurements. The electrochemical cell was a three electrode assembly: Ag/AgCl reference electrode, a platinum electrode (cathode) and the working electrode (anode). A 3,5 % NaCl solution was prepared. Tafel curves along with resistance readings were plotted.

Results and discussion

The microstructure shown in fig. 1 indicates the structural changes of Al-Zn anodes with alloying additives. Tin was dispersed in the matrix and its distribution was found to be dependent on the amount of addition. It is clear that 0,5 wt. % Mg refined the microstructure of the alloy. Further addition caused grain coarsening. These results are expected to affect the corrosion behaviour of the different samples.

The electrochemical properties of the samples were summarized as shown in table 1. Addition of 0,1 % Sn decreased the corrosion rate due to its grain refining effect, however increasing Sn addition increased the corrosion rate. On the other hand, Mg containing samples showed high corrosion rate which is considered an advantage considering the application of the alloy as sacrificial anodes.

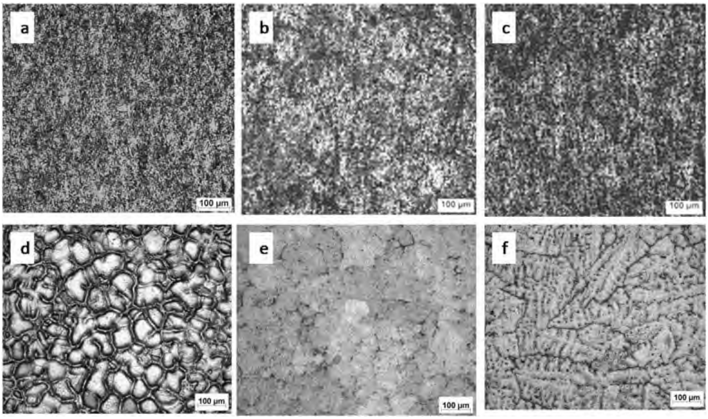

Fig. 1. Microstructure of: a – Al-5 Zn; b – 0,1 Sn; c – 1,0 Sn; d – 0,5 Mg; e – 1,0 Mg; f – 2,0 Mg

Table 1

Sample	**5 Zn**	**0,1 Sn**	**0,6 Sn**	**1,0 Sn**	**0,5 Mg**	**1,0 Mg**	**2,0 Mg**
Corr. rate, mpy	24,14	14,99	20,9	30,41	74,164	57,356	72,67

Conclusions

Addition of Sn or Mg to the standard Al-5 % Zn alloy can significantly alter its properties and hence its application as sacrificial anode.

REFRENCES

1. **Hollingsworth, E. H.** Corrosion of Aluminum and Aluminum Alloy / E. H. Hollingsworth, N. Y. Hunsicker // Metals Handbook. – 1987. – Vol. 13, Corrosion, 9th Ed., ASM International,Metals Park, Ohio. – P. 583.

Acknowledgments

The authors would like to acknowledge the financial support of the Science Technology and Development Fund-Egypt; grant No. 26565.