Electrochemical Impedance Spectroscopy Evaluation of the Skin and Bulk Corrosion Behavior of Die-cast and Thixo-cast AZ91D Alloy in 5% (0.885 M) Sodium Chloride Solution.

S. Jin, N. Giguere, D. Dube, R. Tremblay and E. Ghali*
Dept. of Mining, Metallurgy and Materials Engineering
Laval University, Cité universitaire, QC, Canada

ABSTRACT

The corrosion behavior of die-cast and thixo-cast (with and without electromagnetic stirring) AZ91D was studied in 5% NaCl solution at 25°C and pH 6 using electrochemical impedance spectroscopy (EIS). The charge transfer resistance and double layer capacity were calculated as a function of the distance from the front skin for the three materials. The results showed that the skins were more susceptible to corrosion than the bulks for all of the three samples. The charge transfer resistance of the corrosion process on die-cast AZ91D was always less than those on the two thixo-cast AZ91D samples. The electromagnetic stirring during thixo-casting slightly improved the corrosion resistance of the interior parts, close to the front and back skins of the cast piece, but had no influence on the part in the middle.

Keywords: magnesium alloy, corrosion, chloride solution, electrochemical spectroscopy.

*Author to whom correspondence should be addressed.

ACKNOWLEDGMENTS

We are grateful to the Natural Sciences and Engineering Research Council of Canada for the financial support.

REFERENCES

1. G. Song and A. Atrens, Advanced Engineering Materials, **1**, 11 (1999).
2. C. Blawert, V. Heitmann, E. Morales and W. Dietzel, S. Jin and E. Ghali, paper to be presented to COM 2004 (the Conference of Metallurgists), August 22-25, Hamilton, ON, Canada.
3. S. Mathieu, C. Rapin, J. Hazan, P. Steinmetz, Corr. Sci., **44**, 2737 (2002).
4. G. Song, A.L. Bowles and D.H. StJohn, Mater. Sci.and Eng., **A366**, 74 (2004)
5. R. Ambat, N.N. Aung and W. Zhu, Corr. Sci., **42**, 1433 (2000).
6. G. Song and A. Atrens, Adanced Engineering Materials, **5**, 837 (2003).
7. E. Ghali, W. Dietzel and K-U. Kainer, J. of Mater. Eng. and Perform., **13**, 7 (2004)

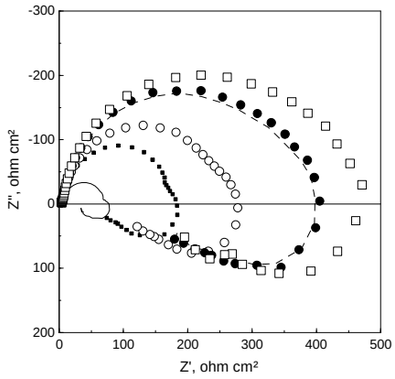

Fig. 1 − Evolution of the corrosion impedance diagram of DC AZ91D alloy as a function of immersion time in 5% NaCl solution at 25°C.
0 hr: continuous line;
1 hr: dots;
2 hrs: open circles;
3. broken line;
4 hrs: filled circles;
5 hrs: open squares.

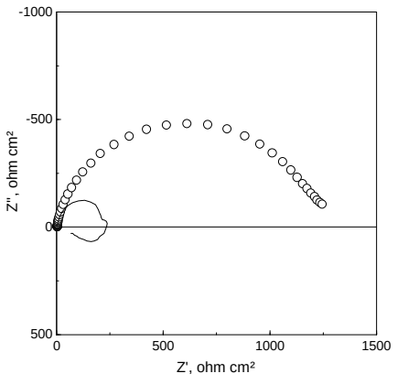

Fig. 2 − Evolution of Nyquist plot of electrochemical impedance of a bulk sample of DC AZ91D alloy immersed in 5% NaCl solution after five minutes: open circles – 0 minute; continuous line – 5 minutes.

Table I ─ R_{ct}, C_{dl}, R_f and C_f values for a bulk sample of DC AZ91D alloy immersed in 5% NaCl solution at the beginning and after 5 min.

Time (min)	R_{ct} (Ω·cm²)	C_{dl} (μF/cm²)	R_f (Ω·cm²)	C_f (μF/cm²)
0	234	16.1	1014	82
5	74.1	1.3	155	60