# AN ELECTROCHEMICAL STUDY OF THE UNUSUAL PASSIVITY EXHIBITED BY ALUMINIUM IN ALKALINE LITHIUM-SALT SOLUTIONS

Anthony B. Cook

*Corrosion and Protection Centre, UMIST, PO Box 88, Manchester M60 1QD, UK*

The corrosion of aluminium, and several of its alloys, in lithium carbonate solution (pH ≥ 11.5) is known to result in the formation of an adherent and persistent salt film [1-7]. The identity of this coating is not entirely clear; some workers suggest it is a hydrotalcite type compound [4, 6], whilst others claim it is simply alumina and lithium aluminate [5]. However, irrespective of its actual composition the surface film increases the substrate's resistance towards localised corrosion and has been recommended as a candidate replacement for chromium (VI) based surface treatments [4]. To date literature pertaining to the mechanism of film formation, and the role of lithium and carbonate therein, remains scarce [2,7].

The mechanism by which aluminium attains a state of pseudo-passivity, in lithium containing solutions, has been investigated at high pH (13.2) with an aluminium wire disk electrode *via* chrono-amperometric means. Current – time profiles obtained on stepping the electrode potential from rest (open circuit) to –0.4 V *versus* $Hg/Hg_2SO_4$ (a potential at which aluminium undergoes diffusion limited dissolution in the corresponding lithium free solution) showed that film formation took place *via* a three-stage process. The first stage could be associated with the formation of lithium aluminate, the second with lithium di-aluminate and the third with the production of a hydrotalcite or related compound (glancing angle XRD provided evidence to support this inference). The relationship between steady-state current density and carbonate ion concentration appeared to follow a Σ shaped curve, with carbonate concentrations $>10^{-2}$ mol $dm^{-3}$ resulting in the lowest solubility surface films.

Experimental current – time profiles, recorded as a function of the lithium and carbonate concentrations, have been successfully modelled using a two-dimensional mathematical description of the filming process.

References

1. Devine, T.M. and Gui, J., *Scr. Metall*. 1987, **21**, 853.
2. Rangel, C. M. and Travassos, M. A., *Corros. Sci.*, 1992, **33(3)**, 327.
3. Craig, J. G., Newman, R. C., Jarrett, M. R. and Holroyd, N. J. H., *J. Phys-Paris*. 1987, **48(C-3)**, 825.
4. Buchheit, R.G., Bode, M.D. and Stoner, G.E., *Corros. Sci*. 1994, **50(3)**, 205-214.
5. Fujino, T., Yogoro, M., Mizumoto, H. & Noguchi, H. *J. Japan Inst. of Light Metals*, 1997, **47(10)**, 533.
6. Perrotta, A. J., Tzeng, S. Y., Imbrogno, W. D., Rolles, R. and Weather, M. S., *J. Mater. Res.*, 1992, **7(12**), 3306.
7. Fernandes, J.C.S. and Ferreira, M.G.S., *Electrochim. Acta* 1992, **37(14)**, 2659.

**Collaborators**

Professor R.C. Newman - *Corrosion and Protection Centre, UMIST, PO Box 88, Manchester M60 1QD, UK*
Dr. N.J.H. Holroyd - *Luxfer Gas Cylinders, 3016 Kansas Avenue, Riverside, CA 92507*