LETTER

Comments on the use of electrochemical impedance for evaluation of disbonding of organic films

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The recent discussion [1, 2] of the use of electrochemical impedance for studying the corrosion protection of steel by organic coatings requires some additional comments. Common to the previous discussion is the assumption that the coating must disbond from the metallic substrate either at the base of a pore or about the base of a pore before a 'break point' can be observed in the impedance spectrum. This assumption is, in general, theoretically incorrect as has recently been pointed out by Kendig *et al.* [3] who consider the case of an organic coating having no disbonding. Consider a coating that contains ionic impurities, for example at a level consistent with that observed by Ruggieri and Beck [4] for a polyurethane coating equilibrated with 0.1M NaCl. It would then exhibit an impedance shown in Fig. 1 where the coating resistance, R_{po}, due to the ionic transport is in parallel with the coating capacitance, C_c, and in series with a double layer capacitance, C_d^o, formed by contact of the polymer with the metallic substrate. Estimates for C_c are based on typical polymer dielectric constants and coating dimensions, while estimates for C_d^o can be derived from Debye–Huckel theory knowing the ionic concentration in the coating [4] and coating dielectric constant. As shown previously, this analysis can predict the onset of breakpoint frequencies at relatively high frequencies without the necessary assumption of disbonding or the existence of pores exposing bare metal [3].

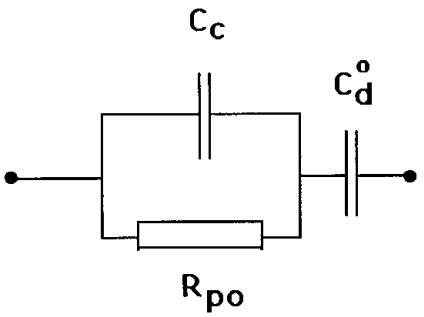

Fig. 1. Schematic representing a metal with an organic film that is not undergoing disbonding.

The issue of predicting coating disbonding from impedance analysis is very important and must be carefully considered. Unfortunately, some hasty assumptions have been made in the past which can be misleading. Recent work in this laboratory suggests that impedance alone is not the best predictor of longer term coating behaviour, but such predictions require supplemental evaluation of corrosion-induced disbonding in order to predict coating life [5].

References

[1] A. T. A. Jenkins and R. D. Armstrong, *J. Appl. Electrochem.* **25** (1995) 1143.
[2] F. Mansfeld, *ibid.* **25** (1995) 1145.
[3] M. W. Kendig, S. Jeanjaquet and J. Lumsden, 'Electrochemical Impedance of Coated Metal Undergoing Adhesion Loss', ASTM STP 1188 (edited by J. R. Scully, D. C. Silverman and M. W. Kendig), American Society for Testing and Materials, PA (1993) pp. 407–27.
[4] R. T. Ruggeri and T. R. Beck, 'The Transport Properties of Polyurethane Paint', *in* 'Corrosion Control by Organic Coatings' (edited by H. Leidheiser, Jr.), National Association of Corrosion Engineers (1981) p. 62.
[5] M. Kendig, S. Jeanjaquet, R. Brown and F. Thomas, submitted for publication in *J. Coat. Technol.*

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