

EIS特性に現れるCPE挙動と塗装系劣化評価への応用

Basic Understanding of CPE Parameters Obtained with EIS Measurements and Their Applications to Degradation Evaluation of Coating Systems

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Abstract

The electrochemical impedance spectroscopy has been expected to be an effective tool for evaluating the deterioration of various kinds of painted steel systems. However, the data analysis is complicated, and it is still difficult to clarify the relationship between obtained parameters and the physicochemical states of coating systems. In this technical paper, we try to explain the physical meaning of the constant phase element (CPE) which is recently used in electrical equivalent circuit models to describe barrier performance of films. Then, CPE behaviors of electrochemical systems including metal oxide films as a simple case study or organic coatings was demonstrated. The oxide films clearly showed CPE behaviors, and the parameters were related to environmental barrier properties of the films. Similar characteristics were also observed for heavy-duty anti-corrosion coatings. Furthermore, an equivalent circuit model which consists of two CPEs in parallel could describe degradation behaviors of the coatings quantitatively. As a possible future application, it is highly expectant that the residual lifetime or risk of blistering of coating systems could be properly estimated by monitoring their parameters periodically.

キーワード：劣化評価、電気化学インピーダンス法、等価回路モデル、定相素子

Keywords: Degradation evaluation, Electrochemical impedance spectroscopy, Electrical equivalent circuit model, Constant phase element

1. はじめに

材料の電気的特性から物理化学的な反応機構を詳細に解析できる電気化学測定法の中で、電気化学インピーダンス法 (Electrochemical Impedance Spectroscopy, EIS) は、大変有用なツールの一つといえる。EIS測定では、測定系 (例えば、溶液と接した金属や塗装鋼板など) に対して、微小な交流信号を入力し、その交流応答を取得する。

具体的には、図1に示したように、測定系

2025年5月7日受付

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