

Current status and advances in corrosion researches

Su-Il Pyun · Sung-Jai Lee

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Corrosion intrudes itself into many parts of our lives, e.g., household appliances, electric power generating plants, airplanes, and automobiles. Many have spent hundreds of dollars on aftermarket corrosion protection systems for new products to delay the dreaded rust appearance [1]. Therefore, the need for corrosion research is based industrially as well as scientifically.

In order to find the protection methods from corrosion, it is first necessary to elucidate corrosion mechanism. For several decades, alternating current (AC) impedance spectroscopy has been developed for studying corrosion mechanism. Among various methods for elucidating corrosion mechanism, AC impedance spectroscopy is the most favorable electrochemical technique since it can provide a quantitative measurement for corrosion [2]. Many researchers have been studying the degradation mechanism of such materials as pure metals, metal alloys, and surface-coated specimens using AC impedance spectroscopy [2–8].

In more recent years, the problem of linearization of electrochemical processes and the possibility of realization of impedance measurements in non-linear conditions have been discussed [9]. For the impedance measurements to be more reliable, a new experimental technique, i.e., dynamic electrochemical impedance spectroscopy (DEIS) was developed [10–12]. Classical impedance spectroscopy can provide information concerning only before and after the corrosion process. In this technique, however, since the electrode impedance is measured continuously in potentiodynamic conditions, DEIS allows to investigate the proceeding corrosion process in time. Hence, one can obtain

very detailed characteristic of the examined corrosion system.

In addition, it has been reported that some corruptions such as pitting corrosion are regarded as a stochastic process at the native oxide films. Since the fluctuations in potential or current associated with the pitting process can be easily observed in the experimental data, electrochemical noise measurement has been newly used for monitoring as well as studying corrosion processes. Many researchers have investigated the pitting corrosion in terms of the statistical variation in the pitting potential and pit embryo density [13–16]. In addition, the pitting corrosion has been described with fractal geometry [17–19].

From now on, some of the protection methods from corrosion will be briefly introduced. In general, the corrosion protections can be classified methodologically into three methods: (1) addition of corrosion inhibitor, (2) formation of protective film by coating, and (3) material design.

First, the preventing methods by adding corrosion inhibitors were explained. In general, inhibitor means the chemical compounds that deposit on exposed material surfaces from the corrosive environment. The inhibitor may form either a uniform film-like coating which acts as a physical barrier or a few monolayers which alter the electrochemical reactivity of the surface to reduce the corrosion rate. In the literatures, the reduction in corrosion rate has been presented by adding metallic inhibitor [20–24] and non-metallic inhibitor [25–31]. Recently, environmentally friendly inhibitors have been widely investigated [32, 33].

Second, the corrosion protections by coating have been presented in corrosion researches. The major advantage of coating is that coatings can preserve the material appearance, which is often a major concern for structures and equipment routinely exposed to public view. There are two kinds of coatings, i.e., organic coating and metallic coating.

S.-I. Pyun (✉) · S.-J. Lee
Korea Advanced Institute of Science and Technology,
Daejeon, Republic of Korea
e-mail: sipyun@kaist.ac.kr

Organic coatings act primarily as a physical barrier between the substrate and the corrosive environment. Metallic coatings also act as a corrosion-resistant physical barrier and, at the same time, provide sacrificial cathodic protection to exposed adjacent areas of a metal substrate of dissimilar composition. There are many literatures concerning the corrosion protection methods by introducing organic coating [34–38] and metallic coating [39–48].

Finally, the corrosion protections were investigated as a function of material composition. Indeed, the most effective method of corrosion prevention is the proper selection of materials resistant to the specific corrosive environment. Hence, the alloy systems comprise the great majority of materials used in engineering applications. Many literatures dealing with the variation of corrosion resistance by compositional change has been published in the field of corrosion research [49–56].

As the above examples show, there is a broad and rapidly increasing range of corrosion researches focusing on the protection methods and we are looking forward to the future progress in corrosion researches. In this report, of course, we can only touch on the limited aspects of the wide area concerning the corrosion mechanism and corrosion protection of corrosion researches. On our personal note, we have learned a lot and even managed to have fun in DEIS technique, fractal theory, and green inhibitor during editing this journal. We hope that everyone might receive the same pleasure and be similarly inspired.

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