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学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Corrosion Protection of Copper by Conductive Polypyrrole Films Incorporated with Inhibitors
(インヒビターを含有した導電性ポリピロール膜による銅の防食)

Copper and its alloys are widely used as structural materials, because the resistivity of copper against corrosion is relatively high. When one uses copper at seashore or in seawater, however, the corrosion damage is much increased and surface finishing for enhancement of corrosion resistivity is thus required. In this study, a new anti-corrosion technique has been developed by a conducting polymer (CP) coating using polypyrrole (PPy) film. For the stable anti-corrosive surface finishing, a self-healing property should be incorporated in the surface coating. For the self-healing property, the PPy films have been doped with corrosion inhibitors of copper, for which phytic acid ($C_6H_{18}O_{24}P_6$, IP₆) and benzotriazole (BTA) have been adopted in this study.

In chapter I, the previous studies on CPs and corrosion protection by using CP coating were reviewed and the aim of this work was described.

In chapter II, the PPy was electrochemically prepared on copper in phytate solution. Phytate compounds existing in various plants has been assumed to be one of environmentally friendly inhibitors of copper. The PPy film thus formed was doped with phytic acid ions simultaneously with the polymerization-deposition. The open circuit potential of the copper covered with the PPy – IP₆ in NaCl solution was maintained in a high potential state for the period longer than 800 h and the dissolution of copper was decreased to 1/19 relative to bare copper.

In chapter III, the effect of the solution pH for preparation of the PPy – IP₆ film and for the protection property in NaCl solution were studied. It was found that the PPy film prepared in the IP₆ solution at pH 4 showed the most protective property. The current density (CD) required for the PPy polymerization was increased with the decrease of solution pH.

In chapter IV, the protection mechanism was examined for the PPy – IP₆ film by using electrochemical quartz crystal microbalance (EQCM) and electrochemical impedance spectroscopy (EIS). From the mass change-potential relation, it was found that the PPy – IP₆ film possessed a cationic permselective property in NaCl solution. The effective protection of PPy – IP₆ film was assumed due to inhibition of penetration of Cl⁻ ions from NaCl solution.

In chapter V, BTA was doped to the PPy film with oxalate ions. BTA is one of the most effective inhibitors against copper corrosion. When BTA was added in oxalic acid solution in the polymerization process, the more homogenous PPy film was formed on copper. The BTA addition to the PPy film enhanced adhesive strength and the corrosion protection property. The copper dissolution was inhibited to 20 percent relative to that of bare copper.

In this work, a new anti-corrosive coating of copper at seashore or in seawater was developed. The conducting PPy coatings doped with corrosion inhibitors of phytate and BTA were prepared on copper and the coatings formed effectively inhibited corrosion of copper.