論 文 内 容 の 要 旨

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Nowadays, the potential use of polymer electrolyte fuel cell (PEFC) for residential applications and electric vehicles has been increasingly attracting the attention of researchers. Due to excellent mechanical properties, low volume and good electrical conductivity, stainless steels as alternative materials have been used for bipolar pate in PEFC. However, stainless steels may suffer from corrosion that can degrade the output power of PEFC when contact with the acidic PEFC environment. Now the high cost of PEFC is a big challenge before PEFC application can be commercialized and the bipolar plates account for 21%. In this work, in order to solve the corrosion problem of stainless steel bipolar plate and decrease the cost of PEFC, we investigate the corrosion behavior of Ni-free inexpensive stainless steel used for bipolar plate in PEFC with and without nitriding heat treatment.

In chapter 1, the overview of the PEFC and bipolar plate were shown and the corrosion problem of metallic bipolar plate and usually used methods to solve this problem were introduced in this chapter. Finally, the purpose of this thesis was shown.

In chapter 2, the corrosion behavior of the four types ferritic stainless steels with different Cr contents have been experimentally investigated to study the effect of Cr content on the corrosion resistance of the ferritic stainless steels as bipolar plate of PEFC in sulfuric acid solution. The results showed that the ferritic stainless steel contains a higher Cr content, a better corrosion resistance is observed.

In chapter 3, Ni-free SUS445 stainless steels were heat treated under a nitrogen atmosphere at 1473 K and 1373 K, and heat treatment was also performed under an argon atmosphere at 1423 K for comparison. The influence of the nitriding process on the microstructure, morphology, surface element component and corrosion behavior of Ni-free SUS445 stainless steel was investigated. All the nitrided samples showed a better corrosion resistance in the Ar-saturated 0.5 mol dm^{-3} H_2SO_4 solution compared to the untreated and heat-treated samples under an argon atmosphere.

In chapter 4, the nitriding treatment of the Ni-free SUS445 stainless steel that contains a higher content of Cr (22.1%) was conducted at 1473 K. The nitrided SUS445-N stainless steel exhibited a significantly improved corrosion resistance and the corrosion type changed from intergranular corrosion to pitting corrosion. The nitride layer composed of the γ_N, CrN and Cr_2N phases with a good electrical conductivity was formed on the surface of the nitrided SUS445-N stainless steel. The CrN and Cr_2N phases are considered the main reason for the excellent corrosion resistance of the nitrided SUS445-N stainless steel.

In chapter 5, the thesis was generally concluded.