

Enhanced photoelectrochemical cathodic protection performance of TiO₂ nanotubes based photocatalyst via synergetic effect of graphene and Co(OH)₂ dopants

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Abstract

Steel materials used in marine environments are vulnerable to corrosion, especially localized corrosion due to the presence of chloride in such environments. Many methods have been developed to protect steel from corrosion in marine environments, including coatings and cathodic protection using sacrificial anodes. Since Tsujikawa and Fujisawa first discovered that TiO₂ could be used as a kind of photoelectrochemical cathodic protection material to protect steel materials, photoelectrochemical cathodic protection method has attracted considerable attention because of its energy conservation and environmentally friendly features.

In this work, we successfully inserted a layer of graphene sheets at the interface between Co(OH)₂ nanoparticles and TiO₂ nanotubes, aiming to improve the photoelectrochemical performance of the large-band gap semiconductor TiO₂ nanotubes. Surface morphology, crystalline structure, optical properties and photoelectrochemical performance of the Co(OH)₂/GR/TiO₂ photoanodes were comparatively investigated. In particular, the photoelectrochemical performance of the Co(OH)₂/GR/TiO₂ photoanode as well as the cathodic protection performance when coupled with 304SS in 3.5 wt.% NaCl solution were also carefully investigated and analyzed in order to deduce the process mechanisms and identify any synergistic effects between the anode materials.

Compared with the blank TiO₂, Co(OH)₂/TiO₂ and GR/TiO₂ photoanodes, the photo-absorption performance, photoelectrochemical performance of Co(OH)₂/GR/TiO₂ photoanode were the best which is mainly due to the good electron conduction of graphene and the hole trapping effect of Co(OH)₂ and their positive synergistic effect. As a result, Co(OH)₂/GR/TiO₂ photoanode produced an effective photocathodic protection for 304SS in 3.5 wt.% NaCl solution at least for 12 h, which would be promising for future practical applications in the field of marine corrosion protection.

Biography

Xiayu Lu is a second-year PhD student from Institute of Metal Research, Chinese Academy of Sciences. Her research direction is the modification and performance research of titanium dioxide photocatalytic materials in marine environment.