

Fabrication and Characterization of a Hydrophobic Nano-TiO₂

Coatings for Corrosion Resistance of Metals

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Corrosion of metals is a long-standing problem in spite of various protection techniques and corrosion resistance materials have been developed. It is generally agreed that one of the most detrimental factors caused corrosion is that metal surface is exposed to a moist environment or in a corrosive media due to the electrochemical reaction happens and in succession different kinds of corrosion appears. Accordingly, various coatings acting primarily as a physical barrier to the corrosive environment and other functions developed rapidly in the past years, as a most common technique to improve corrosion of metals. Recently a great attention has been made in development of surface nano-technology including the organic coatings with nano size pigments and nano size ceramic coatings. Several protective ceramic coating on the metal surface, e.g. nitrides, carbides, silicides or transition metal oxides have been fabricated and characterized by the various approaches. It is noted that the two novel approaches have been developed to improve corrosion resistance for metals by a super-hydrophobic TiO₂ thin films under ultraviolet (UV) illumination and a super-hydrophobic ordered nano-TiO₂ thin coatings obtained by subsequent coating of fluorated silane.

In the present study, an ordered and super-hydrophobic nano-TiO₂ coating was fabricated on metal surface for improving the corrosion resistance. Using ethyl acetoacetate (EAcAc) as a chelating and catalytic agent, an ultra-fine particle of TiO₂ sol was prepared. The particles distribution of TiO₂ sol was characterized by Zeta potential analyzer, the most peak of the particles with 1nm diameter occupied about 71.02%. By mean of the dip-coating method, the three, four or five layers nano-TiO₂ coatings were deposited on the 316L stainless steel and heated at 450°C for 30min. In order to reduce the residual stress between coating and substrate and to prevent from the cracks in the coating, a hydrothermal treatment was applied for the porous nano-TiO₂ coatings by immersed it in the boiling water for 10 min. After post-treatment the coatings became flat and ordered because of restructure and recrystallization during the hydrothermal treatment. The crystalline structure and surface morphology of the nano-TiO₂ coating were analysed XRD and SEM. It was indicated that the TiO₂ particle in the coatings appeared a narrow shape with diameter-size of 15-18nm (Fig.1), and it was composed of anatase crystalline and approx. 0.5-1 μm thickness. Then, the nano-TiO₂ coatings were hydrophobically treated by immersing in a methanol solution of the hydrolysed Hetadecafluorodecyltrimethoxysilane (FSA-13) at room temperature for 1h and subsequently heated at 140°C for 1h. The contract angle of the hydrophobic nano-TiO₂ coatings reached as high as 129° after the treatment.

The corrosion resistance and corrosion behaviors for the nano-TiO₂ coated 316L stainless steel were studied by the electrochemical measurements in 0.5M or 0.1M NaCl solutions. The polarization curves showed in Fig. 2 indicated the corrosion potentials of the nano-TiO₂ coated 316L and FSA treated and nano-TiO₂ coated 316L shifted positively to -0.165V and -0.042 (vs. SCE) respectively, and comparing to the bare 316L stainless steel, the corrosion currents (*i*_{corr}) decreased 2-4 order of magnitudes for the nano-TiO₂ coated 316L in the chloride containing solution. It was proved that the corrosion resistance for the nano-TiO₂ coated 316L and FSA treated and nano-TiO₂ coated 316L increased remarkably by the electrochemical AC impedance measurements. Based on the preliminary

mechanistic study, it is believed that the remarkable corrosion resistance for nano-TiO₂ coated metal is attribute to the super-hydrophobic property, compact physical barrier and cathode protection from the photoelectrochemical effect for the nano-TiO₂ coatings.

ACKNOWLEDGMENTS

Financial support for the Natural Science Foundation of China (Grant numbers: 20127302, 1130-K16002) is gratefully acknowledged.

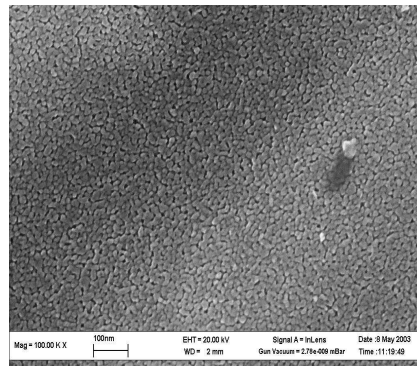


Fig1. SEM photograph of the nano -TiO₂ coated 316L

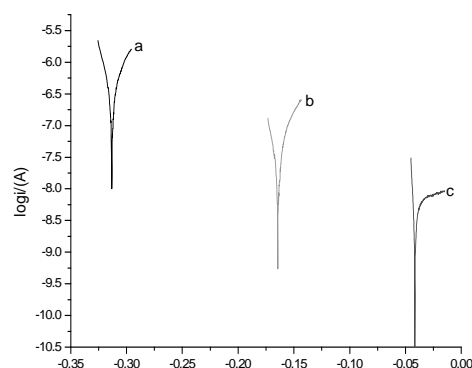


Fig 2. Polarization curves of 316L coated by nano-TiO₂ in 0.1M NaCl solution, a) 316L, b) TiO₂/316L, c) FSA/TiO₂/316L

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