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A novel method to prepare superhydrophobic, UV resistance and anti-corrosion steel surface

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HIGHLIGHTS

- A new superhydrophobic surface with UV and anti-corrosion properties.
- Layer-by-layer deposition of titania and silica nanoparticles.
- Functionalized with PTES (1H,1H,2H,2H-Perfluorodecyltriethoxysilane).
- Static contact angles >165°, advanced angles >170° and slide angle <1°.

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ABSTRACT

Both TiO_2 and SiO_2 coated steel surfaces containing micro- and nanoscale binary structures with different surface roughness were successfully fabricated by means of a facile layer by layer deposition process followed by heat treatment. The resulting surfaces were modified by the low free energy chemical PTES (1H,1H,2H,2H-Perfluorodecyltriethoxysilane). The experimental results of wettability exhibit that such modified surfaces have a strong repulsive force to water droplets, their static contact angles exceed 165°, receding angle >160°, advanced angles >170° and slide angle <1°. The resulting surfaces not only exhibit superhydrophobic properties but also show strong UV resistance (after coating SiO_2 on top of TiO_2) and strong stability to various solvents including 0.01% HCl solution.

1. Introduction

Considered to be the one of the most used materials, the iron and steel have numerous applications. Therefore, the stability of these types of materials under various conditions is of huge concern. Easy and economical way to overcome this problem is to change the surface properties of the steel surface by various coating materials. Making the surface superhydrophobic not only adds anticorrosion property but also introduces self-cleaning function to the surface.

Superhydrophobic surfaces show extreme water repellent and self-cleaning effects due to their unique topographic surface structures. In general, the superhydrophobic surface should have large contact angle (>150°) and small slide angle (<10°) therefore it has various applications include self-cleaning surfaces [1], biomimetic materials [2] and oil–water separation mesh [3]. In this regard, superhydrophobic surfaces have attracted much interest in industry and fundamental research.

In general, micro- and nanoscale hierarchical structures with a hydrophobic top surface are employed to achieve superhydrophobicity. Many methods have been developed to achieve roughness, and consequently superhydrophobicity on metal surfaces. These include laser irradiation [4], electrodeless galvanic deposition [5], and chemical etching on a metal substrate [6]. However, most of these methods are subject to certain limitations such as expensive materials, special equipments, and complex procedures. As an alternative, the superhydrophobic surfaces of metal substrates fabricated by solution-immersion method [7] have been studied in recent years.

In the other hand, protection of steel from corrosion is of great technical importance. Despite the various techniques established for the corrosion resistance of stainless steel, it is well known that steel can be chemically attacked by acids like HCl and HBr, as well as organic acids like citric acid. This problem can be solved by applying various protective coating techniques. Most of the protective

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