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Investigation of photo catalytic activity of titanium dioxide deposited on metallic substrates by plasma technique

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Titanium dioxide (TiO_2) in the anatase crystalline structure corresponds to one of the most powerful photo catalytic materials available today. Photons with the energy equal (UV region) to or higher than its band gap (~3.2 e.V) are able to initiate a photo activation process in TiO_2, which creates hole/electrons pairs in the material. The hole/electron pair consists of high oxidizing and reduction power respectively which can split water into hydroxyl radicals and converting oxygen into superoxide. The hydroxyl and superoxide radicals can decompose various organic materials in contact with TiO_2 surface, maintain anti-bacterial surface.

Metallic material such as stainless steel and light weight aluminium alloys are widely used in several applications from household appliances, transportation, and hospitals to industrial environments. Therefore its combination with a functionalized self-cleaning and anti-microbial surface is extremely attractive for technological applications. However, the behaviour of TiO_2 film on metallic substrates is a little investigated.

In this investigation, TiO_2 coating were made on aluminium alloy (AA1050) and stainless steel (S316) substrate using pulsed DC reactive magnetron sputtering at varying thickness spanning from 100 nm to 2.5 μm . The photo catalytic activity was measured using three techniques namely: (i) electrochemical methods such as Open Circuit Potential (OCP) with and without UV light (ii) decomposition studies of an organic dye (methylene blue) using a flow cell (iii) Optical measurements using reflection. Microstructural investigation was carried out by Atomic force microscopy (AFM), Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD).

The results of the decomposition and the electrochemistry indicated that the choice of the metallic substrate and the thickness of the coating had profound effects on the photo-catalytic properties. The optical measurements demonstrated the ability for coating to absorb light was depended on thickens of the coating. As the coating became thicker, the absorption increases until saturation limited was reach at certain thickness. The quantification of the AFM images showed that there is a linear relationship between the thickness of the coating and the cell size of the crystals.

Keywords: TiO_2 coating, aluminium, stainless steel, magnetron sputtering, photo-catalytic effect