Thermal Treatment of Sol-gel Titania Films Deposited on Stainless Steel for Surface Improvement

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Abstract: ***Four, eight and twelve layers of TiO2 coatings were prepared by the Sol-Gel method. These layers were deposited into SS 316 substrate using dip coating method. The microstructure and surface morphology of titania coatings acquired through sol- gel method were generally assessed using XRD, SEM and optical microscopy, while the composition of titania coating was characterized by EDS. The results revealed that sol-gel deposition succeed in forming titania coating that crystallized in TiO2 (anatase form). The deposited coatings illustrated drastically different composition as well as microstructure in comparison with as- dried coating from the same sol-gel titania group.***

Keywords: *Sol-Gel*, XRD, SEM, SS 316, stainless steel

1. Introduction

Surface engineering can be used to built up a wide range of functional properties, including physical, chemical, electronic, electrical, mechanical, wear-resistant, and corrosion-resistant properties at the required substrate surfaces. These techniques are used in wide range of industries such as the automotive, aerospace, power, machine, biomedical textile, petroleum, petrochemical, steel, cement, machine construction industries ect. Surface engineering is a term that describes various technologies that are used to adjust the surface properties for either metallic or nonmetallic parts for particular or distinctive engineering purposes. *The aim of this article is to* improve the oxidation of stainless steel SS 316 by using Sol-Gel titania coatings [1].

2. Experimental Procedures

First the preparation of titania must be done in the first step then subtracting the samples by taking three samples to insure to have accurate results. Coating the samples is the third step finally heating treatment will be done to get the desirable result.

2.1 Substrate preparation

Three SS 316 samples were cut into small pieces with[2] dimensions of 25mm x 25 mm x 3mm. Then the samples are polished at different stages using grits wheel varying from 150µm to 1µm. Afterwards, the samples were cleaned using acetone and distilled water to give the surface bright finish and eventually all the samples left to dry at room temperature.

2.2 Coating method

Stainless steel substrate SS 316 was hold in dip coating device vertically and then immersed into the sol with constant speed. After a few seconds the substrate was taken out from the sol and left to dry at room temperature. The same procedures were used to coated stainless steel substrates with multi layers ranging from four, eight and twelve layers**.**

2.3 Heat treatment

Conventional furnace was used in order to convert the titans coating into crystal titanium oxide by altering their physical and chemical properties [3].

3. Results and Discussion

The result was in two parts, the first is about the X ray analysis and the last one is analysing the optical microscoping.

3.1X-ray diffraction analysis of titania sol

The XRD analysis of titania sol-gel coatings deposited on SS 316 substrates was undertaken using (HBX, D500 Siemens device). The XRD patterns were collected using Cu Ka radiation with the generator settings of 40kV and 20 mA. The diffraction data were collected over a 2θ range of 20°-50°, with a step width of 0.02° and a counting time of 1s per step. Fig 4 shows the analyses XRD analyses of the sol-gel titania multilayer's coating on stainless steel substrates that heat treated at temperature 850 °C for 1 hour . Rutile phase diffraction peaks appear weak at 2θ = 27.46° and 36.92°with low intensity. Furthermore, one diffraction peak is observed 2θ = 43.68°. and also other peaks are appeared at 2θ = 24°, 32°,29°. and 33.42°.

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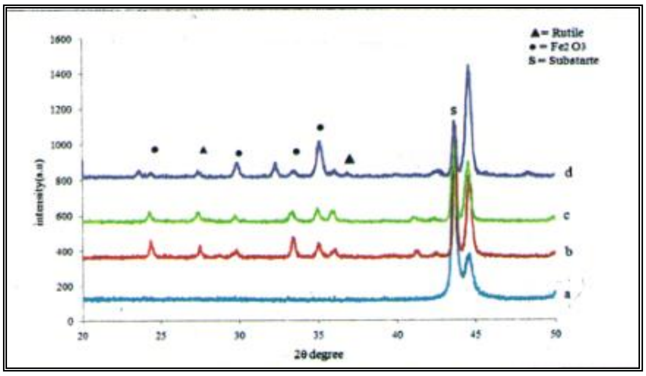

Figure 1: illustrates that titania rutile phase is only observed at temperature 850° for all stainless steel coated samples.

3.2 Optical microscope

Fig 2 shows uncoated and coated SS substrates with multilayer's titania coating ranging from 4, 8 and 12 layers heat treated at 850°C. Fig. 2 uncoated sample shows poor oxidation resistance. In contrast, increasing the number of coating thickness leads to more oxidation resistance as shown with multilayer's coated stainless steel samples.

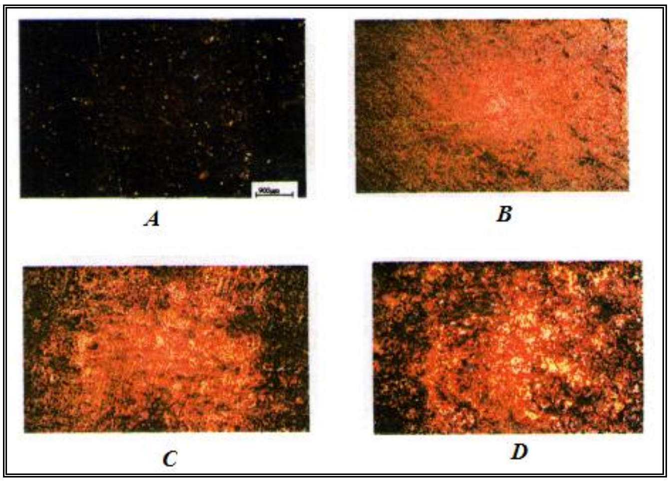

Figure 1: The microstructure analysis of coated stainless steel substrates with different layers (a) un-heated sample. (b) 4 layers. (c) 8 layers. (d)12 layers

4. Conclusion

T sol-gel coating was perfectly deposited onto SS 316 substrates usingitania dip coating method. XRD analysis proved the formation of rutile phase of titanium oxide when heated at high temperature. As predicated, stainless steel coated substrates by multi's layers of titania coatings were more effective to resist the oxidation than uncoated sample.

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