An experimental investigation of corrosion resistance of mild steel by sol–gel process using TiO2 nanostructure coating and prediction of optimal parameters

Article *in* Proceedings of the Institution of Mechanical Engineers Part N Journal of Nanoengineering and Nanosystems · June 2013

DOI: 10.1177/1740349912464930

CITATIONS
2

READS
85

7 authors, including:

Ali Shanaghi
Malayer University
54 PUBLICATIONS **337** CITATIONS
SEE PROFILE

Sahand Tabatabaei
Atlas Copco
33 PUBLICATIONS **164** CITATIONS
SEE PROFILE

Ali-Akbar Karkhaneh Yousefi
University of Tehran
7 PUBLICATIONS **66** CITATIONS
SEE PROFILE

Proceedings of the Institution of Mechanical Engineers, Part N: Journal of Nanoengineering and Nanosystems
http://pin.sagepub.com/

An experimental investigation of corrosion resistance of mild steel by sol-gel process using TiO_2 nanostructure coating and prediction of optimal parameters

Ali Shanaghi, AR Sabour Rouhaghdam, Seyyed Ahmad Tabatabaei, Masoud Shariatpanahi, Abbas Rastgoo, Akbar Karkhaneh Yousefi and Mostafa Samadzadeh

Proceedings of the Institution of Mechanical Engineers, Part N: Journal of Nanoengineering and Nanosystems published online 22 April 2013
DOI: 10.1177/1740349912464930

The online version of this article can be found at:
http://pin.sagepub.com/content/early/2013/04/17/1740349912464930

Published by:
SAGE
http://www.sagepublications.com

On behalf of:
Institution of Mechanical Engineers
Institution of Mechanical Engineers

Technical Note

Institution of MECHANICAL ENGINEERS

Journal of NANOENGINEERING AND NANOSYSTEMS

Proc IMechE Part N:
J Nanoengineering and Nanosystems
0(0) 1–7

DOI: 10.1177/1740349912464930
pin.sagepub.com
SAGE

An experimental investigation of corrosion resistance of mild steel by sol-gel process using TiO_2 nanostructure coating and prediction of optimal parameters

Ali Shanaghi[1], AR Sabour Rouhaghdam[2], Seyyed Ahmad Tabatabaei[3], Masoud Shariatpanahi[3], Abbas Rastgoo[3], Akbar Karkhaneh Yousefi[3] and Mostafa Samadzadeh[3]

Abstract

A TiO_2 nanostructure coating has shown to significantly improve the thermal and electrical properties of steel plates and increase their resistance to oxidation, corrosion, and wear, especially in high temperature applications. In this research, the corrosion resistance properties of a mild steel substrate by applying TiO_2 nanostructure coating using the sol-gel method were investigated. The quality of the coating, however, is notably affected by such process parameters as the dip-coating rate, drying time, heat-treatment rate, and the number of coating layers. Moreover, this article presents an integrated approach to the optimal parameter setting for the above process. Using experimental data from a coating process by the sol-gel method, an artificial neural network is trained to map the vector of process parameters onto a measure of corrosion resistance. An evolutionary search algorithm is then employed to find the optimum set(s) of process parameters. The efficiency of the proposed approach is demonstrated using a case study involving a 316L stainless steel substrate.

Keywords

Nanostructures coating, TiO_2, sol-gel, neural networks

Date received: 12 June 2012; accepted: 19 September 2012

Introduction

Nanostructured TiO_2 thin films are used in a wide range of applications such as ultraviolet filters for optics and packing materials,[1,2] antireflection coatings for photovoltaic cells and passive solar collectors,[3] photo catalysts for purification and treatment of water and air,[4,5] anodes for ion batteries,[6] electro chromic displays,[7] transparent conductors, self-cleaning coatings of windows and tiles,[8] humidity sensors,[9] gas sensors,[10] and barrier layer for corrosion protection.[11] It has been shown that some applications greatly benefited from a nanostructured phase for TiO_2. Indeed, the production of nanostructured TiO_2 thin films has been recently carried out by several methods.[12–14]

Several techniques have been used for the preparation of transparent TiO_2 thin films that include sputtering,[15] chemical vapor deposition,[16,17] pulsed laser deposition,[18] laser molecular-beam epitaxy method,[19] and sol-gel techniques.[20,21] The sol-gel technique has distinct advantages over the other techniques due to excellent compositional control, homogeneity on the molecular level due to the mixing of liquid precursors, and lower crystallization temperature. Moreover, the microstructure of the film deposited, that is, the pore size, pore volume, and surface area, by the sol-gel process can be tailored by the control of process variables[22] and a more generic approach to enhance corrosion resistance is to apply

[1]Department of Materials Engineering, Malayer University, Malayer, Iran
[2]Department of Materials Engineering, Tarbiat Modares University, Tehran, Iran
[3]Department of Mechanical Engineering, University of Tehran, Tehran, Iran

Corresponding author:
Ali Shanaghi, Department of Materials Engineering, Faculty of Engineering, Malayer University, PO Box 95863-65719, Malayer, Iran.
Email: a.shanaghi@malayeru.ac.ir