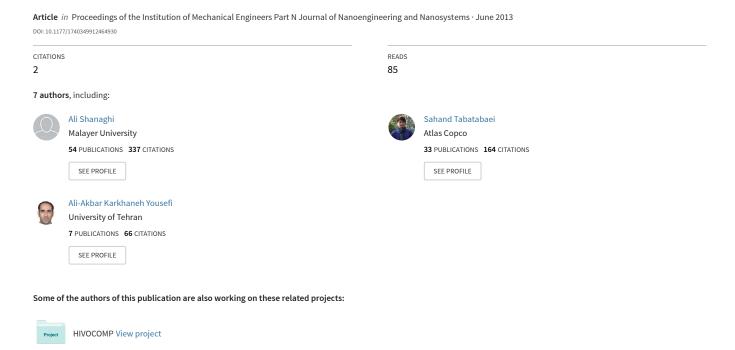
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What is This?



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#### **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<sub>2</sub>, sol-gel, neural networks

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#### Introduction

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

Several techniques have been used for the preparation of transparent TiO<sub>2</sub> thin films that include sputtering, <sup>15</sup> chemical vapor deposition, <sup>16,17</sup> pulsed laser deposition, <sup>18</sup> laser molecular-beam epitaxy method, <sup>19</sup> and sol-gel

techniques.<sup>20,21</sup> 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<sup>22</sup> and a more generic approach to enhance corrosion resistance is to apply

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