Self-healing behaviour of epoxy-based double-layer nanocomposite coatings modified with Zirconia nanoparticles

Graduate Students, Energy and Environment

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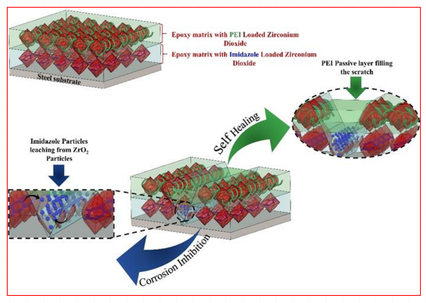
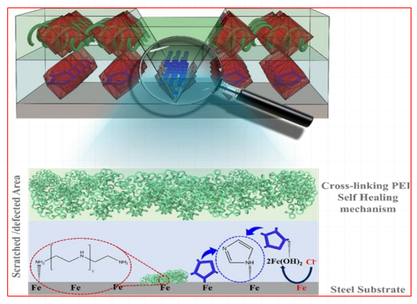
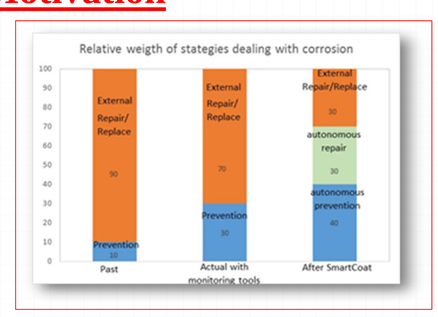
Background

Overview

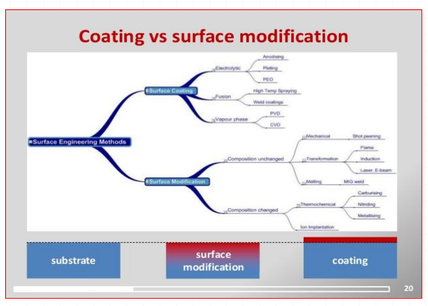


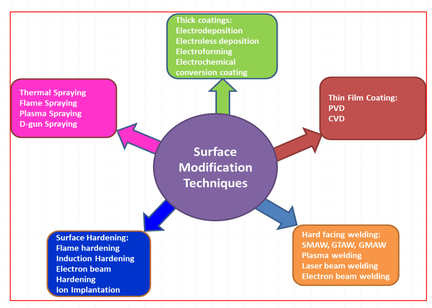


Problem Statement and Motivation

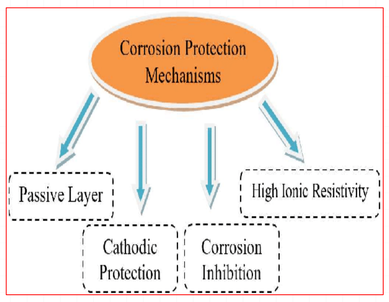


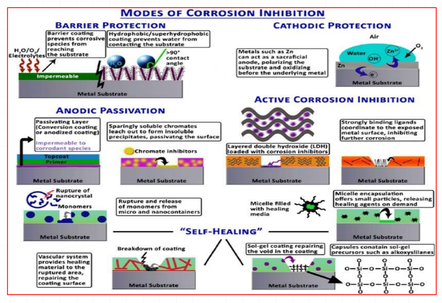
Surface Modification Techniques



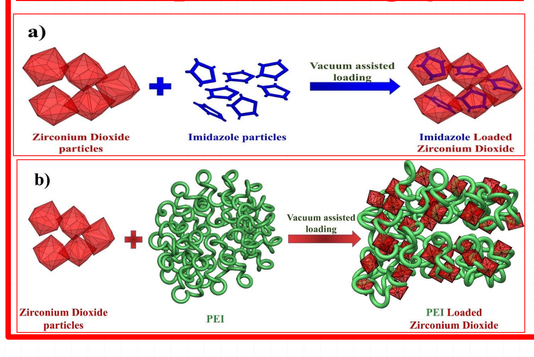


Corrosion Protection Mechanism





Nanocomposite coating system



Results and Discussion

Morphological and structural analysis

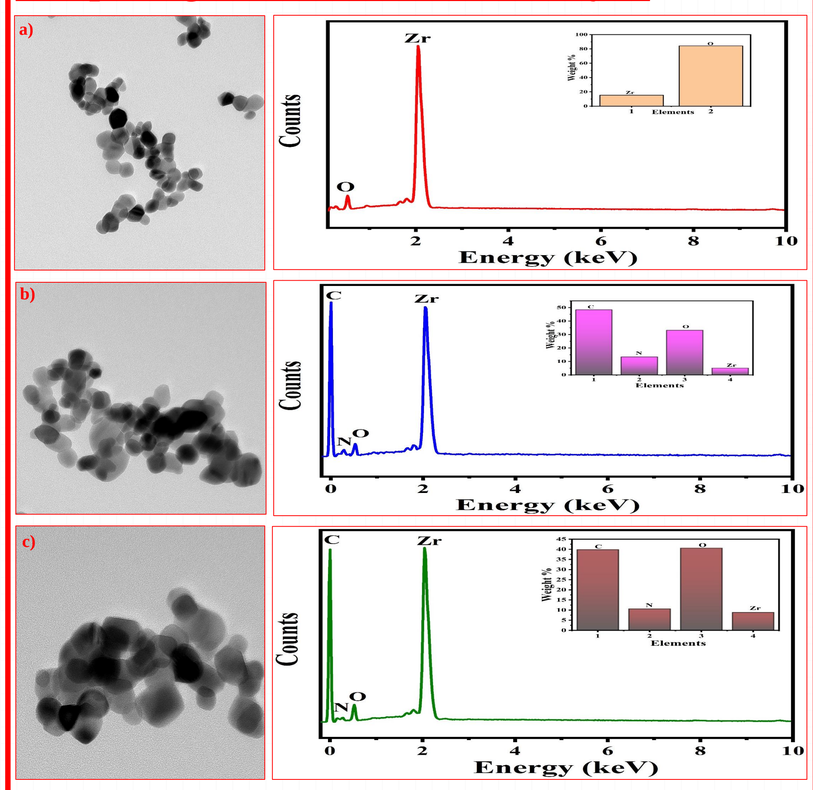


Figure 1: TEM and EDX analysis of (a) Unmodified ZrO2, (b) ZrO2 modified with IM, and (c) ZrO2 modified with PEI.

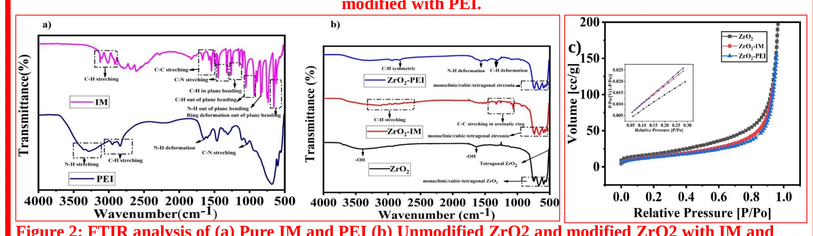


Figure 2: FTIR analysis of (a) Pure IM and PEI (b) Unmodified ZrO2 and modified ZrO2 with IM and PEI (c) BET analysis of unmodified ZrO_2 and modified ZrO_2 with IM and PEI.

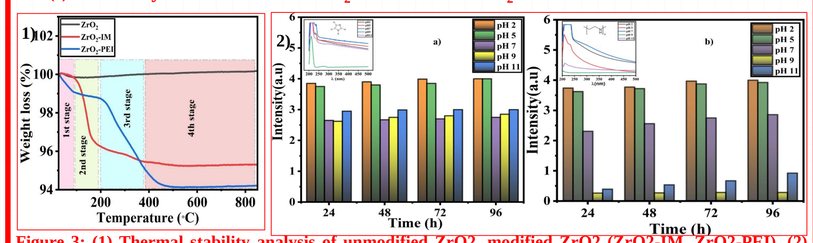


Figure 3: (1) Thermal stability analysis of unmodified ZrO2, modified ZrO2 (ZrO2-IM, ZrO2-PEI). (2) UV-VIS spectroscopic analysis of a) ZrO_2/IM and b) ZrO_2/PEI in different pH solutions (2, 5, 7, 9, and 11) at different time intervals (24, 48, 72, and 96 h) in 0.1 M NaCl solution.

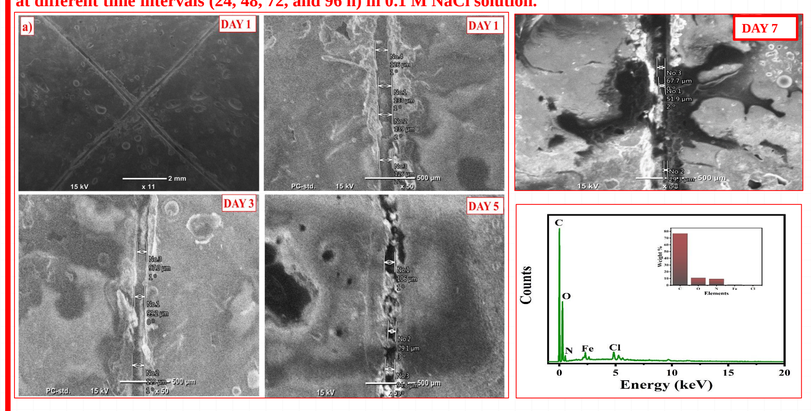


Figure 4: (a) SEM micrographs of scratched epoxy based double-layer nanocomposite coatings demonstrating self-healing performance over 7 days (b) EDX analysis of passive layer formed on the scratched area of the developed epoxy based double-layer nanocomposite coatings.

Corrosion inhibition behavior

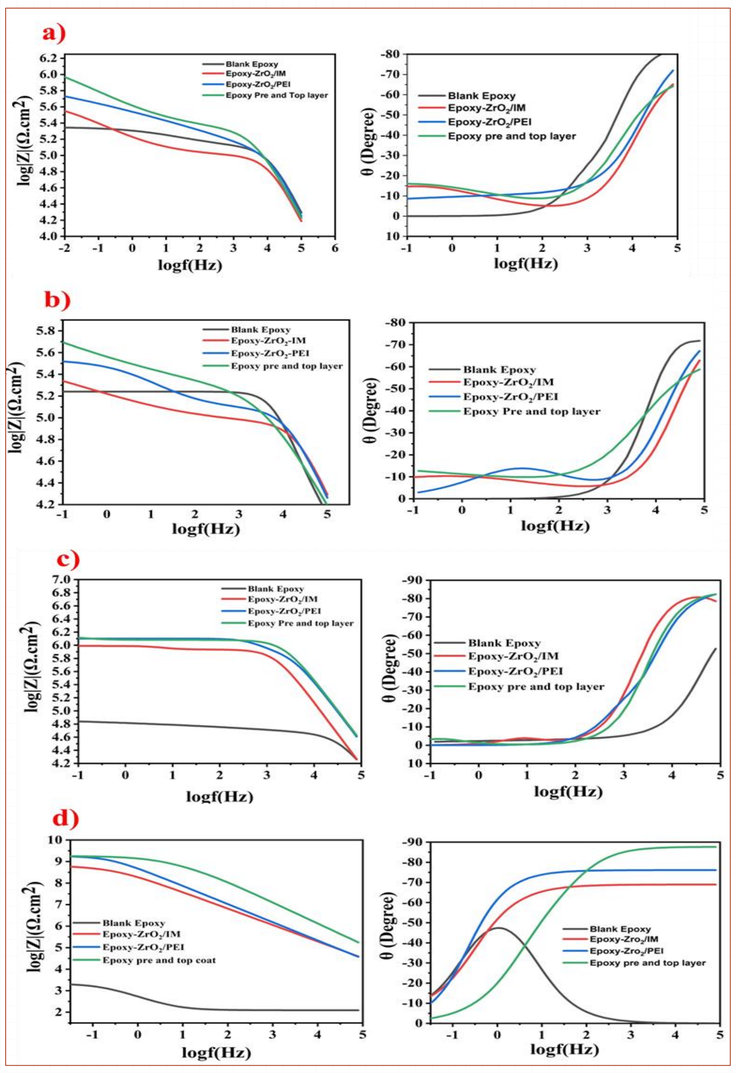


Figure 5: Bode and Phase angle plot a) after 1 day of immersion, b) after 3 days of immersion (c) after 5 days of immersion, (d) after 7 days of immersion for the blank epoxy and epoxy-based nanocomposite coatings.

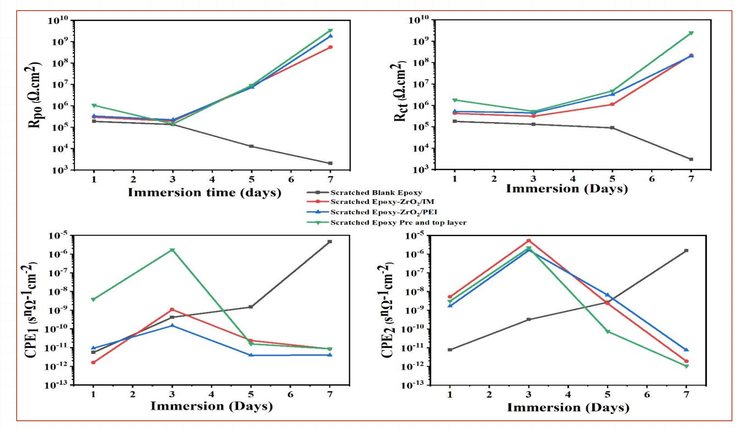


Figure 6: Variation of coating pore resistance Rpo, charge transfer resistance of the coatings Rct, the value of the capacitance CPE1, and value of the capacitance CPE2 at different time intervals of immersion in 3.5 wt. % NaCl solution

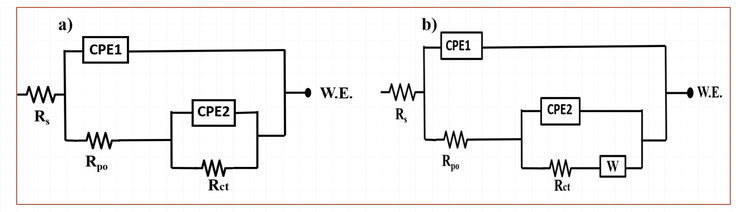


Figure 7: Equivalent circuit used to fit data a) Blank epoxy coatings b) Epoxy based nanocomposite coatings modified with ZrO2 nanoparticles (single layer and double layer).

Impact

The innovative scientific outcomes of epoxy-based coatings target high scientific, economic, social and environmental impact. The breakthrough concept will place epoxy-based coatings into a new level, allowing to boost application of these polymers beyond their state of the art. Moreover, and very importantly, this will deliver a new technical solution that has implications over a wide array of sectors, in which steel coated parts are the key to the operation. These include the Oil & Gas sector and many other industries (infrastructures, construction, desalinization, water transportation, renewable energy production…) in which added value products for corrosion prevention and management are crucial to reduce OPEX.

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Refernces:

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