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# Zinc-rich Paint Modified with Conductive Polymer Particles: Electrochemical Impedance Spectroscopy for Understanding Phenomena in the Coating

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**INTRODUCTION:** Zinc-rich paints (ZRPs) protect carbon steel but present poor mechanical properties due to their high zinc content. This study investigates a modified ZRP incorporating core-shell polymer particles coated with polyaniline emeraldine salt to partially replace zinc. Cross-sectional analysis via scanning electron microscopy (SEM) after immersion, along with electrochemical tests such as open-circuit potential (OCP) monitoring and electrochemical impedance spectroscopy (EIS) in 3.5 % NaCl solution, demonstrated that the coating provides effective cathodic and barrier protection, performing as well as, or even better than, conventional ZRPs.

## METHODOLOGY:

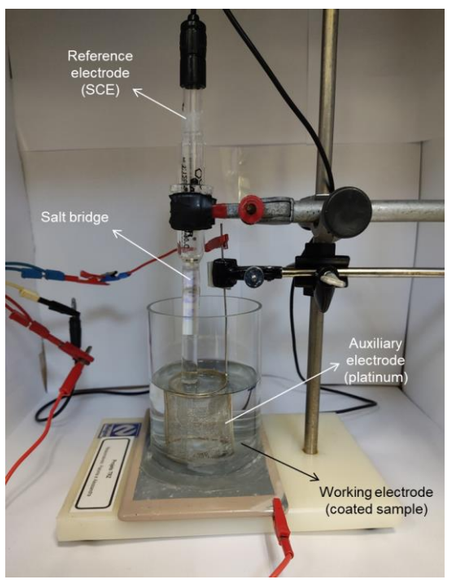


**Fig 1.** Experimental setup for OCP and EIS measurements in 3.5% NaCl.

| | Conventional ZRP (wt.%) | Modified ZRP (wt.%) |
|---|---|---|
| **Binder** | 6.76 | 8.61 |
| **Solvents** | 9.32 | 10.95 |
| **Additives** | 0.19 | 0.19 |
| **Fillers** | 3.04 | 3.01 |
| **Zinc Powder** | 77.25 | 72.67 |
| **Core-shell particles** | - | 0.19 |
| **Curing agent** | 3.44 | 4.38 |

**Table 1.** Composition of the modified and conventional ZRPs.

## RESULTS:




**Fig 2.** SEM cross-sections of the modified ZRPs after immersion in 3.5 % NaCl.

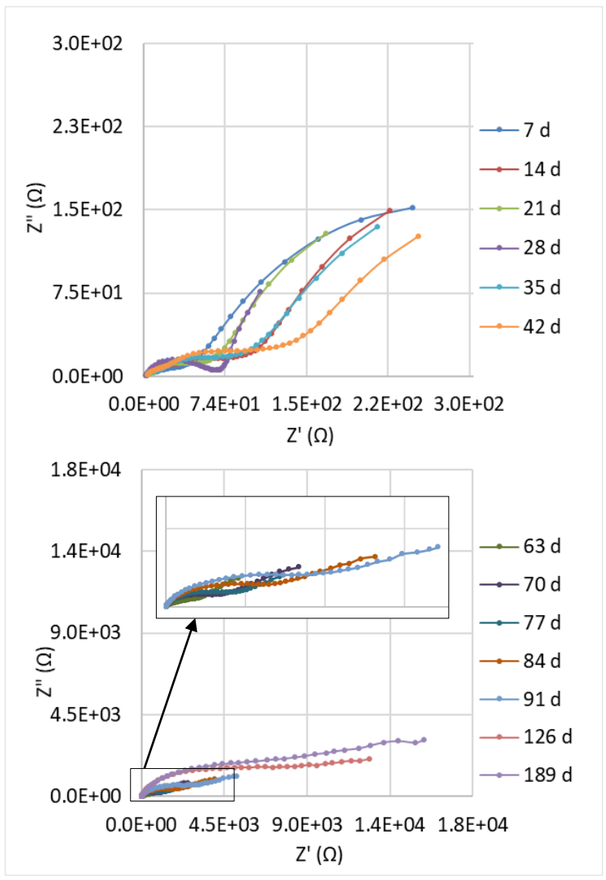


**Fig 3.** Nyquist plots of modified ZRPs.

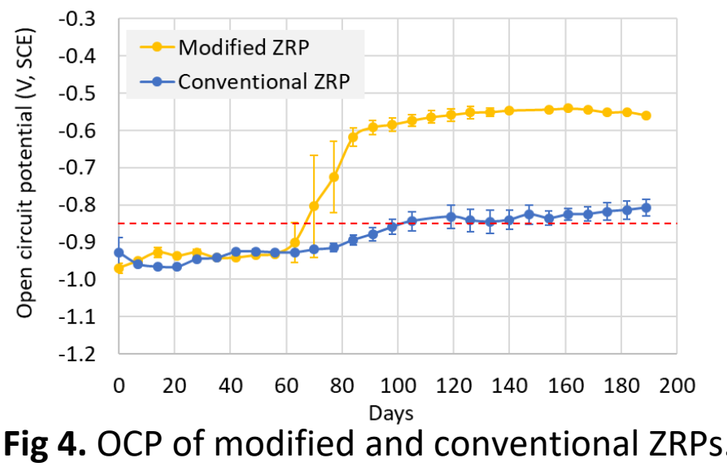


**Fig 4.** OCP of modified and conventional ZRPs.

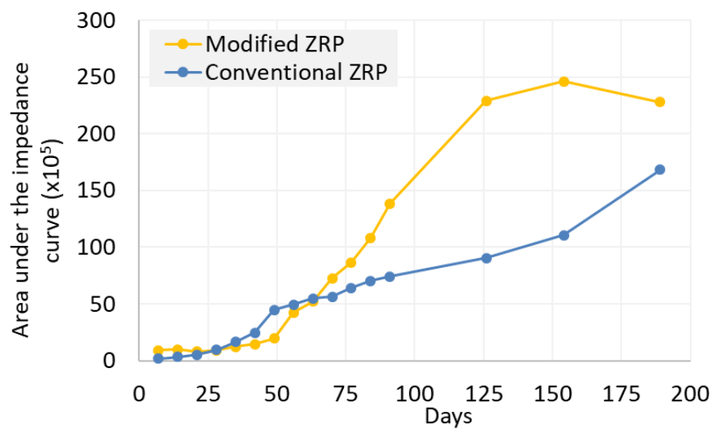


**Fig 5.** Area under the impedance curves of modified and conventional ZRPs.

**CONCLUSIONS:** The modified ZRP showed both barrier and cathodic protection, with corrosion products partially blocking electrolyte pathways. Despite initial permeability, diffusion through the coating decreased over time due to the formation of an oxide layer. Electrochemical tests revealed current flow through insulating regions and a shift from semi-infinite to finite diffusion after 42 days. These findings indicate improved long-term protection performance.

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