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Graphene coatings - A disruptive approach for mitigation of corrosion

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Corrosion and its mitigation costs dearly (any developed economy loses 3-4% of GDP due to corrosion, which translates to ~$250b to annual loss USA). In spite of traditional approaches to corrosion mitigation (e.g., the use of corrosion resistance alloys such as stainless steel and coatings), loss of infrastructure due to corrosion continues to be a vexing problem. So, it is technologically as well as commercially attractive to explore disruptive approaches for durable corrosion resistance. Graphene has triggered unprecedented research excitement for its exceptional characteristics. The most relevant properties of graphene as a corrosion resistance barrier are its remarkable chemical inertness, impermeability, and toughness, i.e., the requirements of an ideal surface barrier coating for corrosion resistance. However, the extent of corrosion resistance has been found to vary considerably in different studies. The author's group has demonstrated an ultra-thin graphene coating to improve the corrosion resistance of copper by two orders of magnitude in an aggressive chloride solution (i.e., similar to sea water). In contrast, other reports suggest the graphene coating actually enhances the corrosion rate of copper, particularly during extended exposures. The author's group has investigated the reasons for such contrast in corrosion resistance due to graphene coating as reported by different researchers. On the basis of the findings, the author's group has succeeded in demonstrating of durable corrosion resistance as a result of the development of suitable graphene coating. The presentation will also assess the challenges in developing corrosion-resistant graphene coating on most common engineering alloys, such as mild steel, and present results demonstrating circumvention of these challenges.

Keywords: Iron oxide nanoparticles; Silver nanoparticles: Male rats; Oxidative stress; Antioxidants; cardiotoxicity, neurotoxicity, and lung toxicity, Cytokines; Mitochondrial transcription factor A peroxisome proliferator activator receptor gamma-coactivator 1α, Biochemical and histology changes.

Recent Publications

1. S. Al-Saadi, R.K. Singh Raman, M.R. Anisur, S. Ahmed, J. Crosswell, M. Alnuwaiser, C. Panter,(2021), Graphene Coating on a Nickel-Copper Alloy (Monel 400) for Microbial Corrosion Resistance: Electrochemical and Surface Characterizations, Corrosion Science, 182 109299.
2. A. Sanjid, M.R. Anisur, R.K. Singh Raman, (2019), Durable Degradation Resistance of Graphene Coated Nickel and Monel-400 as Bi-polar Plates for Proton Exchange Membrane Fuel Cell, Carbon, 151 68-75
3. Anisur, M.R., et al., (2018) Controlling hydrogen environment and cooling during CVD graphene growth on nickel for improved corrosion resistance. Carbon, 127, 131-140.
4. RKS Raman, Z Wang, XL Zhao, G Xian, G Wu, S Al-Saadi, A Haque,(2017), Long-term durability of basalt-and glass-fibre reinforced polymer (BFRP/GFRP) bars in seawater and sea sand concrete environment, Construction and Building Materials 139 , 467-489

Biography

Raman Singh is a professor at Monash University and his research interests include Alloy Nano/Microstructure-Corrosion Relationship, Stress Corrosion Cracking (SCC), Corrosion/SCC of Biomaterials, Corrosion Mitigation by Novel Material (e.g., Graphene), Advanced and Environmentally Friendly Coatings, High-Temperature Corrosion. He has supervised 50 Ph.D. students. He has published over 250 peer-reviewed international journal publications, 15 books/book chapters, and over 100 reviewed conference publications. His professional responsibilities include editor-in-chief of two journals, Fellow ASM International and Engineers Australia, over 40 keynote/plenary talks at international conferences (besides numerous invited talks), leadership (as chairperson) of a few international conferences.

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