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Fabrication of Graphene/Al2O3 coatings with enhanced antibacterial and anticorrosion properties

Abstract
Extreme environments subject materials to conditions far beyond normal service, accelerating degradation through wear, corrosion, microbial or combined effects. The development of innovative nanocoatings is emerging as a viable solution globally because they offer unique advantages over conventional coatings due to their tunable nanoscale architecture, which provides superior surface functionality, enhanced durability, anticorrosive, antimicrobial, and multifunctionality. The selection of nanomaterials is crucial in the preparation of nanocoatings. The incorporation of graphene oxide (GO) and aluminum oxide (Al2O3) into nanocomposite coatings presents a promising augmentation due to synergistic properties of GO and Al2O3. These key attributes include improved mechanical strength, enhanced corrosion resistance, antibacterial properties and superior tribological behaviour. The high surface area, mechanical strength, two-dimensional structure, and functional groups of GO synergise with the hardness and thermal stability of Al2O3. This effective combination creates benefits that can be leveraged across various applications. However, the size of nanoparticles significantly influences the performance of coatings, including their antibacterial and anticorrosive properties. In this study, a GO/Al2O3/epoxy nanocomposite coating was purpose designed with nanoparticle mixing ratios using computational optimization. The impact of aggregation of smaller NPs (Al2O3 - 4 nm) and ten times larger NPs (Al2O3 - 48 nm) and GO towards surface coverage in composite coating has been investigated. High resolution electron and atomic force microscopy (AFM) analyses revealed densely packed nanoaggregates on the surface of GO/Al2O3 coating This coating demonstrated antibacterial properties, effectively combating E. coli bacterial cells, while boasting an impressive hardness of 437 kgf/mm^2. The outcomes of this study indicate that a combination of GO and Al2O3 is paving the way for a highly effective anticorrosive coating that holds great promise for enhancing durability and protection.

Keywords: Nanocoating, Graphene, Aluminium oxide, Antibacterial, Anticorrosive

Biography
Kavinda Manamperi is a PhD candidate at RMIT University, Australia, specializing in the development of advanced multifunctional nanocoatings for environmental, biomedical, and industrial applications. His research focuses on optimizing nanocomposite coatings to enhance durability, corrosion resistance, and antibacterial performance. With a background in material science and nanotechnology, he aims to create sustainable, cost-effective, and scalable solutions that address global challenges in infrastructure and healthcare. His work involves close collaboration with international researchers and emphasizes bridging academic knowledge with real-world industrial applications.