Solid State Phenomena
ISSN: 1662-9779, Vol. 355, pp 3-10
doi:10.4028/p-E1N7Jc

Submitted: 2023-01-20
Revised: 2023-07-10
Accepted: 2023-10-20
Online: 2024-02-15

Improvement on Corrosion and Wear Resistance of Graphene-Based Coatings: A Review

Rihashni Thivagaran[1,a], Mohd Radzi Aridi[2,b], Nurjannah Salim[1,c], Kwok Feng Chong[1,d] and Nurul Huda Abu Bakar[1,e*]

[1]Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia.

[2]College of Engineering, Universiti Tenaga Nasional, Jalan Ikram-Uniten, 43000 Kajang, Selangor, Malaysia.

[a]trihashni@gmail.com, [b]radzi@uniten.edu.my, [c]njannah@ump.edu.my, [d]ckfeng@ump.edu.my, [e]hudabakar@ump.edu.my

Keywords: Graphene-polymer, Graphene-metal, Graphene Oxide, Nanocomposites

Abstract. Poor corrosion and wear resistance of metallic materials lead to deterioration of their properties and may cause failures. In fundamental, corrosion is due to the reaction of metals with their surroundings, such as moisture, salts, and air pollutants. On the other hand, wear is a surface failure because of continuous dynamic contact between the metals' surfaces and other surfaces. In this regard, surface protection such as coatings is crucial to ensure the long life of the metallic materials. Among the surface protection available, graphene-based coatings have emerged as the most researched topic due to their excellent impermeability, chemical inertness, high hardness, and flexibility. It is reported that graphene-metal and graphene-polymer nanocomposite coatings offer versatile protection against corrosion and abrasive wear. Therefore, this review presents the current state-of-the-art graphene-based nanocomposite coatings in the field of corrosion and abrasive wear resistance. This review provides significant approach of graphene-metal and graphene-polymer, as well as the future perspectives of graphene-based coatings.

Introduction

The surface deterioration of metallic materials due to wear and exposure to a harsh environment is an unenviable phenomenon. Many researches have been carried out to improve metals' physical and surface properties to protect them from such situations. The hard coatings are proven could resist corrosion and wear and prolong the useful life of many industrial machinery components, semiconductors, thermal barriers, and bio-medicine materials [1,2]. The coatings successfully improve the surface hardness of the metals and increase the technological aspects of the efficiency and reliability of the underlying metals.

Graphene has been utilized for protection purposes among the hard coatings available due to its superior mechanical properties, impermeability, and chemical stability [3]. Graphene is known to form a coating with just a few atomic layers thick and is said as the thinnest coating for corrosion protection [4]. Graphene could mimic the topological surface of the substrates and sometimes just a minimum of changes to the physical properties of the underlying metals [5]. In principle, coatings could facilitate corrosion protection in three (3) ways; (i) retarding the passageway of current that connects the areas of anodic and cathodic activities on the metal surface, (ii) blocking the corrosion reactions by releasing inhibitor materials that passivate the metal substrates and (iii) provide cathodic protection to the metal substrate if they are pigmented with a more electroactive metal [6]. For graphene, factor (i) is much more relatable as it provides tortuous pathways for corrosive ions and prevents water permeation.

On the other hand, surface deterioration due to wear can be reduced using multiple layers of coatings with different properties. For instance, each layer reduces solid particle erosion by interrupting the stress distribution pattern upon impact and allowing for lower stresses [7]. In this