Corrosion Protection Coatings from Size-Specified Graphene Oxide

Nurul Huda Abu Bakar[1,a], Jamil Ismail[1], Kwok Feng Chong[1,b*]

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

[a]hudabakar@ump.edu.my

[b*]ckfeng@ump.edu.my

Keywords: Graphene oxide, Coatings, EIS, Corrosion

Abstract. Corrosion performance of graphene oxide (GO) coatings from different sheets sizes in 3.5 wt% NaCl solution was investigated. The GO dispersion was subjected to 5 and 10 hours of ultrasonication before electrophoretically deposited (EPD) onto the copper substrate. It was found that the EPD-GO coating from smaller sheets (10h ultrasonication) possess hydrophobic, thinner film and smooth surfaces. It is suggested that the corrosion performance of the coating from smaller GO sheets is improved due to the surface texture and compactness of the coating as compared to the larger GO sheets.

Introduction

The potential of graphene as anti-corrosion coating is undeniable. Several researchers have reported the remarkable findings of graphene in inhibiting the corrosive species that promote corrosion [1, 2]. They provide an unexceptional impassable property that is attributed to their outstanding features such as chemical inertness [3] as well as excellent impermeability to liquid and gasses [4]. Its natural diffusion barrier is expected from the sp^2 carbon allotropes that allow a physical separation between the underlying metal surfaces and corrosive electrolytes, which potentially become the thinnest possible anti-corrosion layer[5].

Recently, one of the essential graphene derivatives that are graphene oxide (GO) has received much attention as a platform for anti-corrosive coating [6, 7]. Similar to graphene, GO also demonstrates excellent thermal and chemical stability [8]. The additional advantage is somehow due to its amphiphilic structure, which consists of a hydrophobic, *p*-conjugated 2D carbon sheet that contains various hydrophilic oxygen functional groups [8]. Its hydrophilic nature facilitates uniform dispersibility in water, thereby beneficial for coating deposition from water-based electrolyte baths such as electrophoretic deposition (EPD).

Acknowledgement

The authors would like to acknowledge the funding from the Ministry of Education Malaysia in the form of [RDU170113: FRGS/1/ 2017/STG07/UMP/01/1] and Universiti Malaysia Pahang grant PGRS180355.

References

1. Tiwari, A. and R. Singh Raman, *Durable Corrosion Resistance of Copper Due to Multi-Layer Graphene.* Materials, 2017. **10**(10): p. 1112.
2. Raman, R.S., et al., *Protecting copper from electrochemical degradation by graphene coating.* Carbon, 2012. **50**(11): p. 4040-4045.
3. Hsieh, Y.-P., et al., *Complete corrosion inhibition through graphene defect passivation.* ACS nano, 2013. **8**(1): p. 443-448.
4. Böhm, S., *Graphene against corrosion.* Nature nanotechnology, 2014. **9**(10): p. 741.
5. Raman, R.S. and A. Tiwari, *Graphene: The thinnest known coating for corrosion protection.* Jom, 2014. **66**(4): p. 637-642.
6. Prabakar, S.R., et al., *Graphene oxide as a corrosion inhibitor for the aluminum current collector in lithium ion batteries.* Carbon, 2013. **52**: p. 128-136.
7. Tong, L., et al., *Enhanced corrosion and wear resistances by graphene oxide coating on the surface of Mg-Zn-Ca alloy.* Carbon, 2016. **109**: p. 340-351.
8. Dreyer, D.R., et al., *The chemistry of graphene oxide.* Chemical society reviews, 2010. **39**(1): p. 228-240.
9. Quezada-Rentería, J., L. Cházaro-Ruiz, and J. Rangel-Mendez, *Synthesis of reduced graphene oxide (rGO) films onto carbon steel by cathodic electrophoretic deposition: Anticorrosive coating.* Carbon, 2017. **122**: p. 266-275.
10. Park, J.H. and J.M. Park, *Electrophoretic deposition of graphene oxide on mild carbon steel for anti-corrosion application.* Surface and Coatings Technology, 2014. **254**: p. 167-174.
11. Ho, C.-Y., et al., *Evaluation of synthesized graphene oxide as corrosion protection film coating on steel substrate by electrophoretic deposition.* Applied Surface Science, 2017.
12. Singh, B.P., et al., *The production of a corrosion resistant graphene reinforced composite coating on copper by electrophoretic deposition.* Carbon, 2013. **61**: p. 47-56.
13. Singh, B.P., et al., *Development of oxidation and corrosion resistance hydrophobic graphene oxide-polymer composite coating on copper*. Surface and Coatings Technology, 2013. **232**: p. 475-481.
14. Rekha, M., A. Kamboj, and C. Srivastava, *Electrochemical behaviour of SnZn-graphene oxide composite coatings.* Thin Solid Films, 2017. **636**: p. 593-601.
15. Qi, X., et al., *Size-specified graphene oxide sheets: ultrasonication assisted preparation and characterization.* Journal of materials science, 2014. **49**(4): p. 1785-1793.
16. Bakar, N.H.A., et al., *Size-dependent corrosion behavior of graphene oxide coating.* Progress in Organic Coatings, 2019. **134**: p. 272-280.
17. Lih, E.T.Y., T.L. Ling, and K.F. Chong, *Facile corrosion protection coating from graphene.* International Journal of Chemical Engineering and Applications, 2012. **3**(6): p. 453.
18. An, S.J., et al., *Thin film fabrication and simultaneous anodic reduction of deposited graphene oxide platelets by electrophoretic deposition.* The Journal of Physical Chemistry Letters, 2010. **1**(8): p. 1259-1263.