Graphene oxide corrosion protection on aluminum foils for cathode electrodes on lithium ion batteries

G. Paterakis[1,2,#], **G. Anagnostopoulos**[1*], **L. Sygellou**[1] and **C. Galiotis**[1,2]

[1]Institute of Chemical Engineering Sciences, Foundation of Research and Technology-Hellas (FORTH/ICE-HT), Stadiou Street, Platani, Patras, 26504 Greece

[2]Department of Chemical Engineering, University of Patras, Patras 26504 Greece

Presenting author: XXX, email: gpaterakis@iceht.forth.gr
* Corresponding author: XXX, email: anagnostopoulos@iceht.forth.gr

ABSTRACT

Lithium-ion batteries (LIBs) are indispensable for everyday life as power sources for many electronic devices (mobile phones, laptops, tablets, etc). Their use in the coming years is expected to increase further due to the growing need for such devices as well as the transition of the car market to electricity [1]. The most accepted cathode current collector for LIBs is the aluminum (Al) foil. However, is susceptible to local anodic corrosion during long-term operations of charging and discharging. These corrosion reactions on the cathode electrode could lead to the deterioration or even premature failure of the batteries and generally are considered to be a main drawback for next-generation LIBs [2]. On the other hand graphene, a single-atom-thick sheet of carbon with unique properties and impressive impermeability to gases and atoms up to helium (He), seems to hold promise as an effective anticorrosion barrier [3].

Herein, we present a comprehensive experimental investigation of the protection of Al foils in corrosive environments using graphene relative materials (GRM). We use graphene oxide (GO), functionalized graphene oxide (GO-Li) and electrochemical reduced forms of them (erGO, erGO-Li) as conformal thin coatings on the Al foils for their corrosion protection and we compare their properties with commercial Al foils coated with GRM. It is demonstrated that Al foils by graphene materials coatings exhibits significantly reinforced anodic corrosion resistance in both lithium perchlorate ($LiClO_4$ – 1M) and sulfuric acid (H_2SO_4 – 0.5M) electrolytes. The graphene oxides (GOs) specimens showed complete coverage of the Al surface with a simple dip-coating process providing a thin film, up to 6 nm. Moreover, they can post-electrochemically reduced, in order to improve their properties, leading to better corrosion protection. Furthermore, Al foils coated by GOs demonstrate enhanced electrochemical performance in comparison with the commercial GRM coated specimens and presented lower corrosion rates in both corrosive environments. More specifically, the corrosion inhibition efficiency (η) of erGO coated specimens in $LiClO_4$ and H_2SO_4 electrolytes was 72.9 % and 94.2 %, respectively, providing the better characteristics.

REFERENCES

[1] Scrosati, B.; Abraham, K.; van Schalkwijk, W. A.; Hassoun, J., *Lithium batteries: advanced technologies and applications*. John Wiley & Sons: Hoboken, New Jersey, 2013; Vol. 58.

[2] Wang, M.; Tang, M.; Chen, S.; Ci, H.; Wang, K.; Shi, L.; Lin, L.; Ren, H.; Shan, J.; Gao, P.; Liu, Z.; Peng, H., Graphene-Armored Aluminum Foil with Enhanced Anticorrosion Performance as Current Collectors for Lithium-Ion Battery. *Advanced Materials* **2017,** *29* (47), 1703882.

[3] Nine, M. J.; Cole, M. A.; Tran, D. N.; Losic, D., Graphene: a multipurpose material for protective coatings. *Journal of Materials Chemistry A* **2015,** *3* (24), 12580-12602.