

Nanocomposite Materials based on Differently Oxidized Graphene for Oxygen Electrocatalysis

M. Longhi,^{a,b} E. Pargoletti,^{a,b} G. Cerrato,^c G. Consolati,^d S. Patané,^e S. Santangelo,^f M. Scavini,^a and G. Cappelletti,^{a,b}

^a Dipartimento di Chimica, Università degli Studi di Milano, via Golgi 19, 20133, Milano, Italy

^b Consorzio Interuniversitario Nazionale per la Scienza e Tecnologia dei Materiali (INSTM), Via Giusti 9, 50121, Firenze, Italy

^c Dipartimento di Chimica & NIS, Università degli Studi di Torino, Via P. Giuria 7, 10125 Turin, Italy

^d Department of Aerospace Science and Technology, Politecnico di Milano, via La Masa 34, 20156 Milano, Italy

^e Dipartimento di Scienze Matematiche e Informatiche, Scienze Fisiche e Scienze della Terra, Università di Messina, Viale Stagno d'Alcontres 31, 98166 Messina, Italy

^f Dipartimento di Ingegneria Civile, dell'Energia, dell'Ambiente e dei Materiali, Università "Mediterranea", Via Graziella, Loc. Feo di Vito, 89122 Reggio Calabria, Italy
e-mail presenting author: leonora.pargoletti@unimi.it

Since the discovery of graphene oxide (GO) in the 19th century, many researchers have focused their attention on exploring its remarkable potentialities for different applications [1-3]. Indeed, this two-dimensional material possesses very interesting electronic, thermal, optical and mechanical features. In addition, its main advantage with respect to pristine graphene is the presence of an electronic band gap thanks to the oxygen-containing functionalities introduced by chemical treatment. Notably, the decoration of graphene sheets with oxygen groups also provides opportunities to tune the aforementioned properties by controlling the oxidation degree and, above all, these oxygen functionalities can represent an anchor point for the further growth of metal oxide (MOS) nanoparticles. Indeed, the intimate contact between GO and MOS-based electrocatalysts can boost the final electrochemical performances thanks to the higher conductivity given by the carbonaceous material [3,4].

Therefore, herein, we report a deep analysis of the modification of the GO properties by increasing the oxidation degree, giving also an insight into the interlayer gap by means of several physicochemical techniques. In particular, Positron Annihilation Lifetime Spectroscopy (PALS) measurements shed light into the gap tuning by changing the oxidizing agent amount in the GO synthetic route. Then, the tailored coupling between GO and metal oxide nanoparticles (such as cerium or praseodymium oxides) was finely characterized on morphological (TEM), structural (XRPD, Raman) and surface (BET-BJH, XPS) points of view. Finally, a correlation between the peculiar GO features coupled with MOS in the hybrid materials and the ultimate electrocatalytic performances towards oxygen reactions in aqueous media were deeply investigated. Preliminary promising results were obtained.

References

- [1] P. Johari et al., *ACS Nano*, **2011**, 5, 7640–7647.
- [2] G. Panzarasa et al., *Carbon*, **2019**, 5, 6.
- [3] V. Sapner et al., *RCS Adv.*, **2019**, 9, 6444-6451.
- [4] Y. Zhao et al., *Scientific Reports*, **2015**, 5, 7629.