Nanocatalysts based on Graphene Oxide for Fuel Cell Application

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Fuel cells have the potential to be an efficient and versatile power source. They can operate on a wide range of fuels, and the technology can be scaled from self-powered nanodevices, portable fuel cells in laptops, up to large stationary installations.

Among the different types of fuel cells, microbial fuel cell (MFC) has recently gained much attention because of its ability to generate clean power from organic waste via microorganisms, eliminating at the same time some of the problems linked to waste disposal [1]. Current limitations related to MFC technology are the high cost associated to materials, the low electrochemical performance, and the low durability of the electrodes. The main problem is certainly related to the oxygen reduction reaction (ORR) at the cathode side. Nanotechnology is able to address this issue; in fact, the development of new carbon nanostructures with highly tunable morphology and structure has led to the use of graphene for the assembly of components of MFC cathodes. It has been demonstrated that ORR is effectively catalyzed by graphene-based materials due to high density of active sites, high electrical conductivity, and ease of functionalization [2,3]. However, challenges, such as complexity in synthesis and high costs, still limit the applicability of graphene as cathode component of MFCs.

This presentation will deal with the development of low cost and effective catalysts based on graphene oxide (GO) for cathodes of MFCs. We developed different strategies to include nitrogen functionalities in GO matrix, including post treatments based on annealing with ammonia gas and one-step nitrogen-doping. By combining the use of electrochemical and spectroscopic techniques, we correlated the different morphology and surface chemistry of the prepared materials with catalytic activity towards ORR. The applicability of GO as ORR catalysts was evaluated by assembling single chamber air-cathodes MFCs, which power and voltage generation over time were acquired. The obtained results demonstrated the potential ability of GO electrocatalysts to boost the electrochemical performance of MFCs

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[2] Yong, Y.-C., Dong, X.-C., Chan-Park, M.B., Song, H., Chen, P. (**2012**) *ACS Nano*, 6 (3), pp. 2394-2400.

[3] Costa de Oliveira, M.A., Mecheri, B., D'Epifanio, A., Placidi, E., Arciprete, F., Valentini, F., Perandini, A., Valentini, V., Licoccia, S. (**2017**) *Journal of Power Sources*, 356, pp. 381-388.