Electrocatalytic performance of different carbon-based materials in the electrochemical production of H_2O_2

Raul José Alves Felisardo[1], Oswaldo Costa Junior[1], Marcos Roberto de Vasconcelos Lanza[1*]
[1]São Carlos Institute of Chemistry, University of São Paulo
*e-mail: marcoslanza@usp.br

Electrochemical production of hydrogen peroxide (H_2O_2) via 2e$^-$ oxygen reduction reaction (ORR) has attracted increasing attention in the scientific community as a sustainable and efficient approach [1]. This study evaluated various carbon-based materials, Printex L6 carbon (PL6C), graphene (GRA), and HiBlack carbon (HB), as catalysts for ORR to develop gas diffusion electrodes (GDE) capable of *in situ* H_2O_2 generation. Materials were characterized using a rotating ring-disk electrode (RRDE), scanning electron microscopy (SEM), X-ray diffraction (XRD), Raman spectroscopy, elemental analysis, surface area measurements, and contact angle tests. The study focused on how structural and electrochemical properties influence ORR performance and H_2O_2 electrogeneration. Electrochemical tests were conducted at current densities of 10, 20, and 40 mA cm^{-2} in acidic and alkaline media. Results showed that electrolyte pH significantly affects H_2O_2 production. Higher cathodic currents and oxygen reduction rates were observed at pH 9, while activity decreased at pH 5 with more negative onset potentials. Particle morphology, size, and surface chemical groups were also found to directly impact ORR efficiency. Additionally, H_2O_2 accumulation increased with current density. These findings highlight the critical role of carbon material selection and its physical-chemical characteristics in optimizing electrochemical H_2O_2 production.

Acknowledgments:

This study was financed, in part, by the São Paulo Research Foundation (FAPESP), Brazil. Process Number #2023/13260-2, #2024/11170-9, #2018/22022-0, #2019/06650-3 and #2022/12895-1.

References:

[1] P.J.M. Cordeiro-Junior, M.S. Kronka, L.A. Goulart, N.C. Veríssimo, L.H. Mascaro, M.C. dos Santos, R. Bertazzoli, M.R. de V. Lanza, J Catal 392 (2020) 56–68.