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Sustainable H_2O_2 electrogeneration employing gas diffusion electrodes produced from tannin-cellulose xerogel

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Nowadays, on-demand hydrogen peroxide (H_2O_2) electrogeneration via 2-electron-oxygen reduction reaction (ORR) stands out as a promising chemical route, offering a sustainable and versatile alternative to the conventional methodology fraught with environmental concerns and centralized production constraints [1]. In this context, gas diffusion electrodes (GDEs) have been proven to be highly effective in H_2O_2 electrogeneration [2]. Carbonaceous materials, including graphene, graphene oxide, carbon nanotubes, and carbon blacks, find extensive use in the fabrication of GDEs [3]. However, producing these materials typically entails high costs and complex procedures, posing challenges to their cost-effective application [3]. Therefore, the pursuit of sustainable GDEs emerges as a promising avenue. There is growing enthusiasm surrounding using natural carbon sources derived from plants, like cellulose and tannin, to synthesize functional materials. Biomass-based carbon gels have emerged as promising materials within this domain, offering a pathway to create low-cost multifunctional carbonaceous materials[4,5]. However, there needs to be more insights on the utilization of these materials in electrochemical processes.

Thus, this study presents the production and application of novel and sustainable gas diffusion electrodes based on cellulose/tannin carbon xerogel for the electrogeneration of H_2O_2. Initial electrochemical characterization by using a rotating ring-disk electrode setup (RRDE) reveals that integrating tannin into the carbon xerogel enhances selectivity towards H_2O_2 electrogeneration while subjecting it to higher calcination temperatures prompts a positive shift in the ORR activity (Figure 1A). This behavior was related to morphological changes induced by the tannin inclusion and calcination temperature, such as an altered morphology and increased surface area. Regarding H_2O_2 electrogeneration, the GDE developed exhibits a peak production rate of 32.5 mg L^{-1} h^{-1} cm^{-2} of H_2O_2 at 100 mA cm^{-2} (Figure 1B), highlighting the applicability of this GDE towards H_2O_2-based processes.

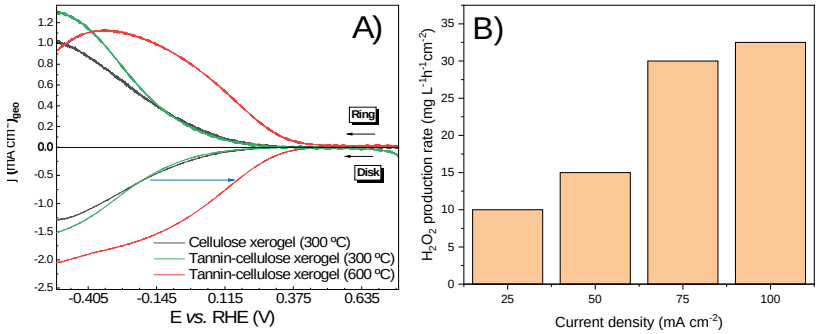

Figure 1 – A) Linear sweep voltammetry for the synthesized materials (O_2-saturated, 0.05 mol L^{-1} K_2SO_4, pH 3); B) H_2O_2 production rate using the synthesized GDE-Tannin-cellulose (600 ºC) (O_2 flow = 0.05 L min^{-1}, 0.05 mol L^{-1} K_2SO_4, pH 3)

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