Towards the application of state-of-the-art catalysts using environmentally friendly support: use of Pd-single atoms supported onto biomass-derived carbon in gaseous diffusion electrodes for H_2O_2 electrogeneration

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Hydrogen peroxide (H_2O_2) is one of the most important chemical compounds in modern society, widely used in diverse applications across the globe. Its industrial production is predominantly centralized and based on the anthraquinone reduction process, which poses limitations for certain applications[1]. This is particularly true in cases where transportation and storage are hazardous or economically unfeasible, especially when only small quantities of H_2O_2 are required, or in applications with low added value, such as environmental remediation and water treatment. To address these challenges, *in situ* electrochemical production of H_2O_2 has emerged as a promising alternative. However, most of the commonly used carbon materials, such as Printex L6 and Vulcan XC72, are derived from environmentally unfriendly processes. In this work, we propose an alternative to conventional materials by utilizing biomass-derived carbon obtained from sugarcane bagasse. The material was further modified with Pd in the form of atomically dispersed single atoms to enhance catalytic performance. The resulting materials were systematically optimized to maximize H_2O_2 production, and their performance was evaluated using electrochemical techniques. The optimized catalyst containing 1 wt.% atomically dispersed Pd exhibited state-of-the-art performance, achieving an onset potential close to the thermodynamic limit for the two-electron oxygen reduction pathway in acidic media (0.667 V vs. RHE) and high selectivity (approximately 90%). The next phase of this research involves the application of this catalyst in a laboratory-scale reactor, employing gas diffusion electrodes to validate its performance under realistic operational conditions.

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References:

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