Anodic Production of Hydrogen Peroxide on Carbon-based Materials

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The production of hydrogen peroxide (H_2O_2) using renewable electricity, oxygen (O_2) and water (H_2O) is an alternate ''green'' route to the current anthraquinone process[1]. There are two approaches for the electrochemical synthesis of H_2O_2. One pathway is the partial reduction of O_2 at cathodes employing either noble metal alloys or doped carbon. Another possible route is the two-electron oxidation of water to H_2O_2, which competes with the four-electron oxidation of H_2O to O_2[2]. This anodic production of H_2O_2 is desirable since it can be coupled with other cathodic reactions, such as CO_2 reduction reaction to valuable products. However, it remains a great challenge to develop efficient electrocatalysts for H_2O_2 anodic synthesis, which can suppress the thermodynamically favored oxygen evolution reaction (OER). The objective of our research is to identify the parameters that will allow maximizing the efficiency of the catalyst and the electrochemical process for the anodic production of H_2O_2. Carbon has been used as an electrocatalyst due to its large surface area, conductivity, chemical stability in alkaline electrolytes, and low cost. Selective oxidation of water to hydrogen peroxide on different carbon materials was conducted using a two compartment H-cell, where copper was used as a counter electrode. The impact of electrolyte concentration, current density, pH values of the electrolyte, temperature, and ion exchange membranes, have been investigated in order to optimize reaction conditions for the anodic production of H_2O_2. A concentration of 1.73 mM for H_2O_2 was achieved at the applied current density of 100 mA cm^{-2} in 2.7 M $KHCO_3$ electrolyte using a cation exchange membrane in a flow cell. (**Figure 1**).

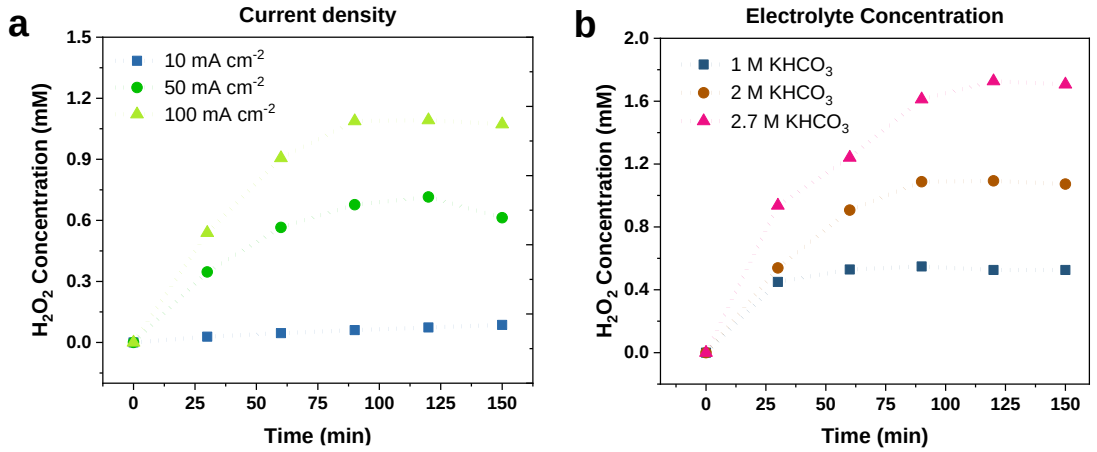

Figure 1: Hydrogen peroxide concentration in the anolyte during electrolysis at **(a)** different current densities using 2 M $KHCO_3$ and **(b)** in different electrolyte concentrations of $KHCO_3$ at 100 mA cm^{-2}

References:

[1] S. C. Perry, D. Pangotra, L. Vieira, L.-I. Csepei, V. Sieber, L. Wang, C. Ponce de León and F. C. Walsh, *Nature Reviews Chemistry* **2019**, *3*, 442-458.
[2] K. Fuku and K. Sayama, *Chem Commun (Camb)* **2016**, *52*, 5406-5409.

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