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A new step toward to a better understanding of the biomass electro-conversion: Electrooxidation of glucose/xylose mixtures on PdAu based nanocatalysts

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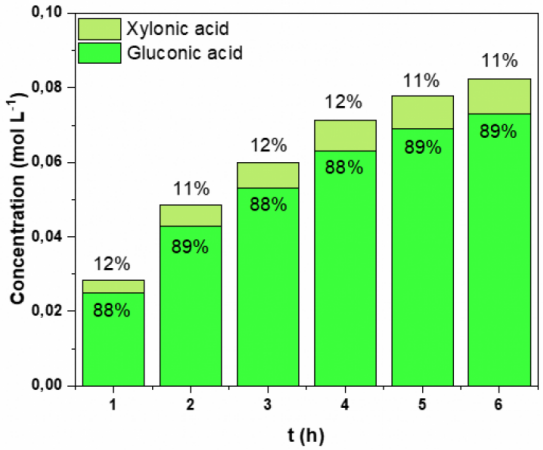
PURPOSE OF THE ABSTRACT

Glucose and xylose are the main sugars in hydrolysates after lignocellulosic biomass pretreatments to separate lignin from carbohydrates, and it has been proposed that the economically feasible production of valuable chemicals from lignocellulosic biomass should also lean on the conversion of both xylose and glucose [1]. For example, the carboxylic acid derivatives of glucose and xylose, gluconic and xylonic acids, respectively, are of great interest as bio-sourced platform molecules [2] for a large panel of applications [3,4].

The electro-conversion of oxygenated compounds from biomass is now considered as an interesting mean for the simultaneous production of both value-added compounds at the anode and of hydrogen at the cathode of an electrolysis cell [5,6]. Moreover, we recently showed that each of these sugars could be electrooxidized with very high conversion rate and selectivity into their corresponding acid form using carbon supported alloyed Pd1-xAux/C nanostructured materials, with the Pd0.3Au0.7/C one leading to the higher catalytic performances [7].

The electro-reforming of 0.10 mol L-1 glucose/xylose mixtures has been evaluated at Pd1-xAux/C anodes in 0.10 mol L-1 NaOH electrolyte. Because cellulose and hemicellulose are each present at about the same ratio in lignocellulosic biomass [8], that cellulose contains only hexoses, and that hemicellulose contains both pentoses and hexoses [9], the electrocatalytic behaviors of Pd1-xAux/C materials will be studied in alkaline aqueous glucose/xylose mixtures with molar ratios 90%/10%, 70%/30% and 50%/50 and compared to those for pure glucose and xylose solutions. From linear scan voltammetry and in-situ Fourier transform infrared spectroscopy measurements, it was shown that the Pd0.3Au0.7/C material led to the best electrocatalytic behavior towards the electrooxidation of glucose/xylose mixtures in terms of activity (higher current densities at lower potentials) and selectivity (lower dissociative adsorption). Six-hour chronoamperometry measurements were performed at 293 K in a 25 cm2 electrolysis cell at of +0.4 V and +0.6 V and the reaction products were analyzed by high performance liquid chromatography. The main products were gluconate and xylonate, but the contributions of xylose to the whole products formed was always lower in percentages than the initial xylose ratios in solutions, showing that glucose was more electro-reactive than xylose at Pd0.3Au0.7 surface.

FIGURES



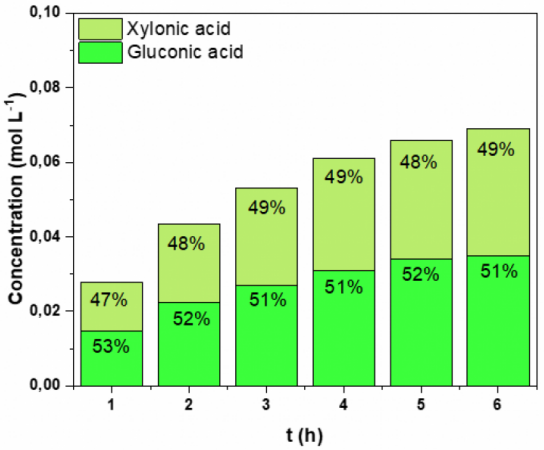


FIGURE 1

Oxidation of 0,1 M of mixture glucose (90%) xylose (10%) at 0,6 V

Histograms of product distribution (gluconic, xylonic acids) as a function of time determined by HPLC during the electrochronoamperometry measurement for 6 hours at 293 K for the electroreforming of 0.1 mol L-1 glucose 90% / xylose 10 %

FIGURE 2

Oxidation of 0,1 M of mixture glucose (50%) xylose (50%) at 0,6 V

Histograms of product distribution (gluconic, xylonic acids) as a function of time determined by HPLC during the electrochronoamperometry measurement for 6 hours at 293 K for the electroreforming of 0.1 mol L-1 glucose 50% / xylose 50 % at cell voltages

KEYWORDS

Electroreforming | Glucose | Xylose | Mixtures

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