Ni-W catalysts for cellulose-derived ethylene glycol one-pot synthesis: advancing sustainable production

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To help with issues of global environmental problems and diminishing fossil fuel reserves, lignocellulosic biomass is attracting attention as raw-material for the production of green chemicals [1,2]. One of the most interesting routes for its valorisation is the one-pot hydrolytic hydrogenation into valuable chemicals, such as ethylene glycol (EG) [3,4]. EG is an alcohol with two –OH groups, widely used in pharmaceutical, cosmetic, food, dye, plastic and automobile industries, which allows it to be considered a high-value market product [5].

In this work, the direct hydrolytic hydrogenation of cellulose to EG was evaluated using Ni and W mono- and bimetallic catalysts supported on carbon nanotubes (CNT). Furthermore, the influence of the metal loading was investigated. In standard tests, 300 mL of water, 750 mg of cellulose (previously ball-milled for 4 h at 20 s^{-1}) and 300 mg of catalyst were introduced into a 1000 mL stainless steel reactor under stirring at 300 rpm. After heating under N_2 to 205 ºC, the reaction was initiated by switching to H_2 (50 bar), and the reaction mixture was analysed by high performance liquid chromatography (HPLC) and total organic carbon (TOC) evaluation. The properties of the synthesized catalysts were characterized by several techniques, such as N_2 adsorption, microscopy (SEM/EDS), XRD, TG, ICP and TPR.

Conversions of cellulose around 100% were reached after 5 h in all experiments, and a synergistic effect was observed between Ni and W, allowing the tuning of the EG yield by changing the weight ratio between both metals. An EG yield over 50% was reached in just 5 h of reaction using 20%Ni-20%W/CNT as catalyst [6]. This result greatly surpassed those previously obtained using Ru-W/CNT under the same conditions [7-9], indicating that a cheaper metal such as Ni can successfully replace the Ru noble metal.

In conclusion, Ni-W/CNT catalysts are efficient for the direct EG production from cellulose, being presented herein as low-cost and sustainable catalytic alternatives.

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