7th International Conference

WASTES

SOLUTIONS
TREATMENTS
OPPORTUNITIES

BOOK OF PROCEEDINGS

7th International Conference

WASTES

SOLUTIONS
TREATMENTS
OPPORTUNITIES

FUNCHAL, MADEIRA
VIDAMAR HOTEL
3 – 5 SEPTEMBER 2025

BOOK OF PROCEEDINGS

COVER
Pragmatic

EDITORS
Joana Carvalho, Zlatina Genisheva, Margarida Soares e Cândida Vilarinho

PUBLISHER
CVR - Centro para a valorização de Resíduos

AUTHORS
Multiple

TITLE
Proceedings of the 7th International Conference WASTES: Solutions, Treatments and Opportunities

ISSN
2183-0568

SUSTAINABLE ETHYLENE GLYCOL PRODUCTION FROM CELLULOSE OVER FRUIT PEEL WASTE-DERIVED CARBON SUPPORTED Ni-W CATALYSTS

L.S. Ribeiro[1,2]*, R.G. Morais[1,2], A.C. Damas[1,2], J.J.M. Órfão[1,2], M.F.R. Pereira[1,2]

[1] LSRE-LCM – Laboratory of Separation and Reaction Engineering – Laboratory of Catalysis and Materials, Faculty of Engineering, University of Porto, Porto, Portugal

[2] AliCE – Associate Laboratory in Chemical Engineering, Faculty of Engineering, University of Porto, Porto, Portugal

*Corresponding Author: lucilia@fe.up.pt

ABSTRACT

The efficient use of renewable biomass is crucial for reducing CO2 emissions. Direct conversion of cellulose, the most abundant component of lignocellulosic biomass, to ethylene glycol (EG) is a promising pathway [1-2]. EG plays an important role in the synthesis of high-value chemicals with high market demand, such as polymers (e.g., polyester fibres), antifreeze products and cosmetics [3]. On the other hand, to address the pressing issue of waste accumulation, the synthesis of carbon materials from various waste sources has become a prominent area of research [1]. In particular, biomass-derived carbons have attracted considerable attention as a sustainable alternative to expensive commercial carbon catalyst supports, such as carbon nanotubes [4]. Therefore, this work focused on the synthesis of low-cost food waste-derived carbon supported Ni-W catalysts for the sustainable production of EG directly from cellulose.

Fruit peel-derived carbons were synthesised by hydrothermal carbonisation (HTC) of banana and orange peels, followed by a thermal treatment under N2 atmosphere for 2 h at 700 °C to develop the porosity of the resulting materials [5]. In addition, a carbon support was prepared by hydrothermal polymerisation of glucose followed by thermal treatment under the same conditions as above, resulting in the sample CG (carbonised glucose). Subsequently, Ni-W catalysts (20 wt.% Ni and 10 wt.% W) were prepared by incipient wetness impregnation on the previously carbonised banana (CB), carbonised orange (CO) and CG. The catalysts were evaluated in the one-pot hydrolytic hydrogenation of cellulose, for which 300 mL of water, 750 mg of ball-milled cellulose and 300 mg of catalyst were added to a 1000 mL stainless steel Parr reactor under stirring at 300 rpm. After heating under nitrogen to 205 ºC, the reaction was initiated by switching to hydrogen (50 bar) and the reaction mixture was analysed by high performance liquid chromatography (HPLC) and total organic carbon (TOC). The properties of the materials and catalysts were characterised by various techniques, such as N2 adsorption, ICP, TG, XPS, Raman spectroscopy, TEM, SEM, EDS and XRD.

Figure 1 shows the results of cellulose conversion and EG yields after 5 h. The synthesised catalysts showed remarkable activity in the conversion of cellulose (100 %), resulting in an impressive EG yield of up to 50 % over Ni-W/CG. Among the two waste-based catalysts, Ni-W/CB showed the best performance, allowing the production of about 45 % of EG in only 5 h. Furthermore, this catalyst showed an admirable reusability, resulting in similar EG yields during four consecutive runs.

Keywords

food wastes valorisation; hydrolytic hydrogenation; Ni-W catalysts; ethylene glycol