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Pd/CNT catalysts for glycerol electro-oxidation: Effect of Pd loading on production of valuable chemical products

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Abstract

Glycerol ($C_3H_8O_3$), a waste product from biodiesel synthesis, is considered as a suitable substrate for electro-oxidation process to generate high value-added products. In this work, palladium nanoparticles supported over activated multi-walled carbon nanotubes (MWCNTs) with varying loadings of 5%-40% were prepared using chemical reduction method. It was further employed for electro-oxidation of glycerol to produce various high value-added products. The catalysts were characterized by different physicochemical methods, such as x-ray diffraction (XRD), liquid N_2 physisorption, and transmission electron microscopy (TEM), whereas the electro-oxidation activity of the catalysts was analysed using cyclic voltammetry (CV) and chronoamperometry (CA). The products were identified by high performance liquid chromatography (HPLC). It was found that the electrochemical surface area (S_{ESA}) and mass activity (MA) have increased from 176.98 $m^2\ g^{-1}$ to 282.29 $m^2\ g^{-1}$ and 12.22 mA mg^{-1} to 49.53 mA mg^{-1}, respectively, by increasing the Pd-loading from 5% to 20%. A further increase to 40% Pd loading showed that, the S_{ESA} and MA values decreased to 231.45 $m^2\ g^{-1}$ and 47.63 mA mg^{-1}. The optimum 20% Pd-loading showed excellent electrochemical properties due to uniform distribution of Pd-metal particles over MWCNTs. HPLC results showed that tartronic acid, glyceric acid and glyceraldehyde formed the dominant products. Mechanism of the reaction has also been proposed based on product distribution.

Key Words: Pd/MWCNT; electrocatalyst; glycerol oxidation reaction, HPLC, metal loading

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