Fabrication and Catalytic Performance of Electrospun HPA Supported in Pt-TiO_2 Nanofibers for Hydrodeoxygenation

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Sustainable fuels and chemical additives derived from biomass are gaining traction due to heightened climate change awareness and the demand for energy security. However, only a small fraction (~2 %) of the aromatic-rich lignocellulosic biomass produced annually from pulp and paper industry is converted into useful products.[1] Hydrothermal liquefaction of biomass yields alternative renewable energy sources such as bio-oils that contain undesirable oxygenated compounds. Catalytic hydrodeoxygenation (HDO) processes aim to convert these compounds into high-quality hydrocarbons, but efficient catalyst development remains a challenge due to the requirement for high hydrogen pressure.[2]

In this work, electrospinning (ES) is used to fabricate catalytic nanofiber scaffolds for biofuel conversion (*Fig 1*). The catalytic scaffolds produced were functionalized with TiO_2 and Pt nanoparticles (NPs) and tungstosilicic acid crystals (Pt-TiO_2-HPA). To produce the catalytic scaffolds, chloroplatinic acid and a titanium salt were dispersed in a polyvinylpyrrolidone (PVP)-acetic acid and ethanol solution prior to ES. Following deposition of the fibers, wet impregnation was used to incorporate HPA. The resulting catalytic scaffold was evaluated for HDO performance in a batch reactor containing phenol dissolved in hexadecane. The Pt-TiO_2-HPA catalyst demonstrated promising HDO performance, achieving 100 % benzene selectivity and 29 % conversion of phenol. Characterization of the synthesized Pt-TiO_2-HPA nanofibers was conducted using field-emission scanning electron microscopy (FESEM), energy-dispersive X-ray spectroscopy (EDS), and powder X-ray diffraction (XRD). Thermal stability, surface area, and porosity analysis revealed advantageous properties of the electrospun fibers, with a BET surface area of 16.9 $m^2\ g^{-1}$ and mesoporous characteristics suggesting potential selectivity benefits. This fabrication method lays the groundwork for optimizing ES catalysts and enhancing energy conversion performance. The presence of tungstosilicic acid on the anatase fibers compensated for the extremely low concentration of Pt particles. The authors aim to improve Pt loading on the nanofibers by utilizing other crystal growth techniques such as polyol reduction (*Fig 2*).

[1]G. Velvizhi, P.J. Jacqueline, N.P. Shetti, L. K, G. Mohanakrishna, T.M. Aminabhavi, Emerging trends and advances in valorization of lignocellulosic biomass to biofuels, J Environ Manage 345 (2023) 118527.
[2]D. Supramono, J. Tjioe, A. Kiswanto, Effect of polypropylene pyrolyzate as the solvent on hydrodeoxygenation of palm oil using Ni-Cu/ZrO2 catalyst, S Afr J Chem Eng 47 (2024) 220–232.

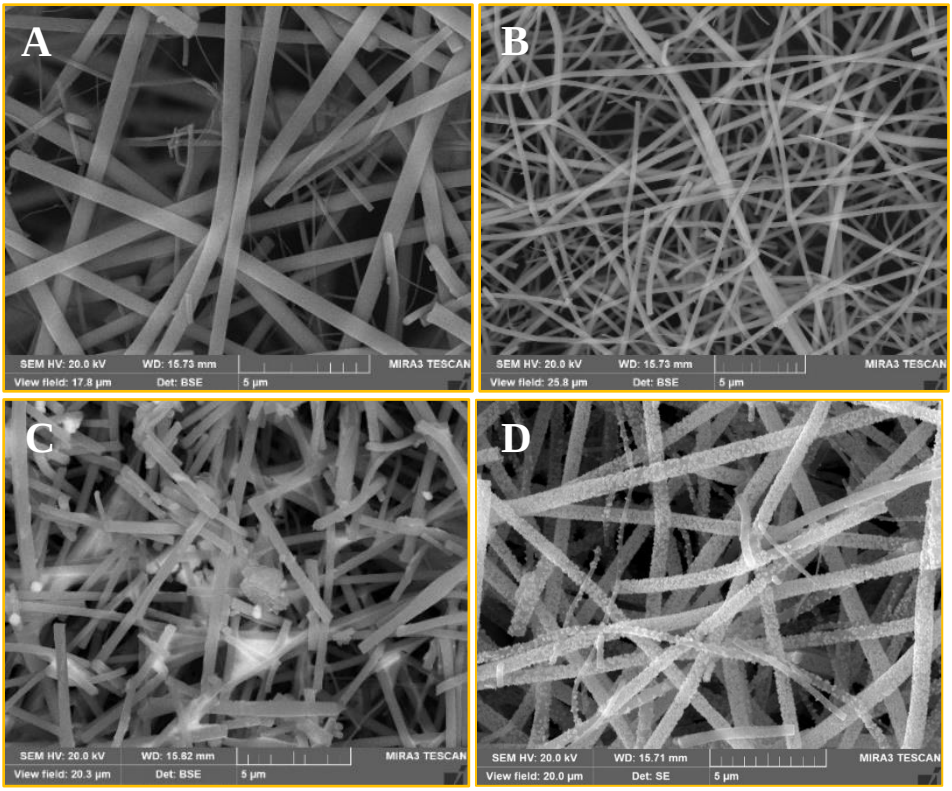

Fig 1: *(**A**) As spun PVP containing Pt-TiO_2 fibers, (**B**) ES Pt-TiO2 fibers after 3 h sintering in nitrogen atmosphere at 550 °C, (**C**) Pt-TiO_2 fibers impregnated with HPA followed by 3 h calcination in air at 300 °C to strengthen HPA onto the fibers, and **(D)** postmortem of Pt-TiO_2-HPA scaffold after catalytic HDO.*

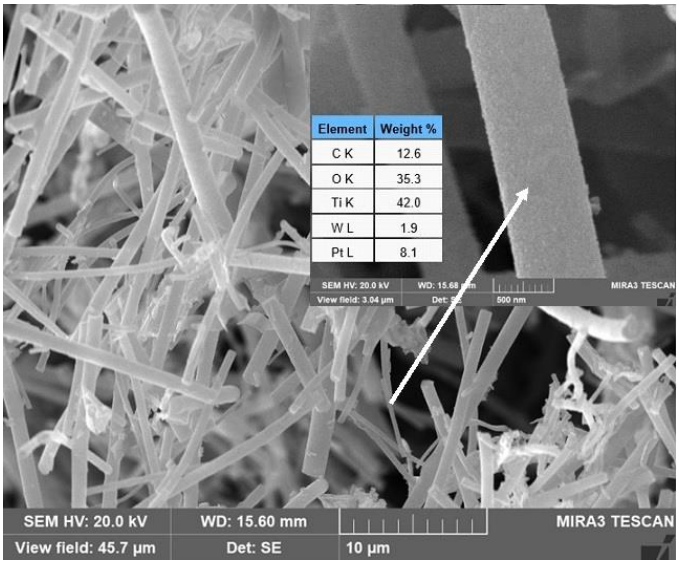

Fig 2: *SEM Micrograph of Pt nanoparticle-decorated TiO_2-HPA nanofibers synthesized via polyol process.*