ISGC 2022

N°291 / OC
TOPIC(s) : Homogenous, heterogenous and biocatalysis / Chemical engineering

A green sustainable and recyclable Pd@LNPs nanocatalyst with high catalytic performance for catalytic reduction of Cr(VI) and 4-nitrophenol and Suzuki reaction

AUTHORS

ZHAO ZHANG / UNIVERSITÉ DE TECHNOLOGIE DE COMPIÈGNE, CENTRE DE RECHERCHE ROYALLIEU-CS 60 319-60 203 COMPIÈGNE CEDEX, FRANCE, COMPIÈGNE
Vincent TERRASSON / UNIVERSITÉ DE TECHNOLOGIE DE COMPIÈGNE, CENTRE DE RECHERCHE ROYALLIEU-CS 60 319-60 203 COMPIÈGNE CEDEX, FRANCE, COMPIÈGNE
Corresponding author : Erwann GUÉNIN / erwann.guenin@utc.fr

PURPOSE OF THE ABSTRACT

In recent years, the development of nanoscience and nanotechnology has widely penetrated into the field of catalytic research [1]. The most typical example of which is the emergence of nanocatalysts and the flourishing of their related research [2]. Nanomaterials have unique crystal structure and surface properties, and their catalytic activity and selectivity are much higher than those of conventional catalysts [3]. At the same time, precious metal nanoparticles have been commonly used in the fields of chemistry, materials, energy, environment, medicine, organic chemical catalysis and electrochemical catalysis [4]. Palladium nanocatalysts are widely used in petrochemicals, automotive exhaust treatment, fuel cells and other fields [5]. In addition, the Suzuki coupling reaction catalyzed by palladium is one of the important means to construct C-C bonds, which has important applications in organic synthesis [6,7].

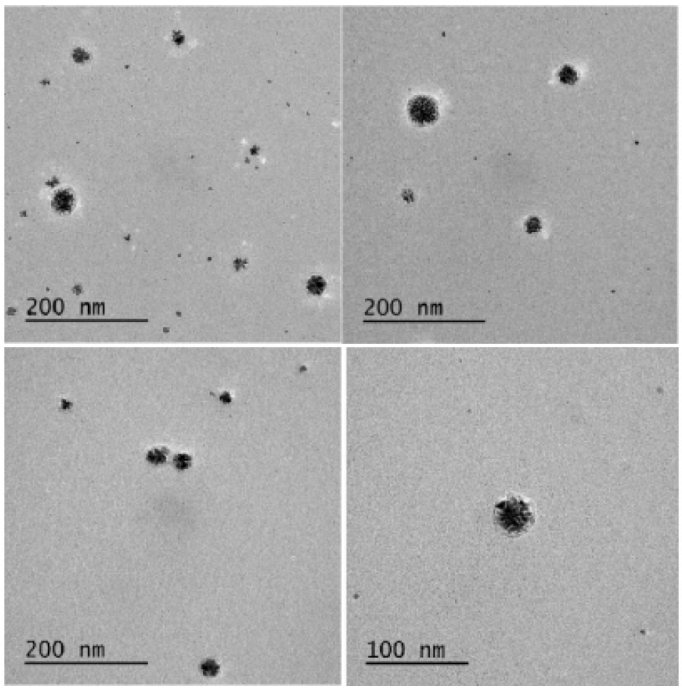
However, the conventional supported catalysts have disadvantages such as complex preparation process, relatively expensive raw materials, and non-reusable catalysts [8]. In addition, the difficulty of combining the metal palladium with the carrier during the preparation process and the loss of metal palladium during the reaction are all problems to be solved [9]. Since the structure and properties of the carrier have a very important influence on the performance of the catalyst. Therefore, the development of new catalyst carriers is an effective way to improve the catalytic activity, stability and recoverability of precious metal catalysts [10].

As the second most abundant natural polymer material after cellulose, lignin has received extensive attention in recent years [11]. The development of bio-based products from lignin is an important part of any comprehensive biorefinery concept because of their biocompatibility and biodegradability [12]. Currently, the exploitation of nanolignin is the subject of a tremendous amount of research [13]. Lignin nanoparticles have potential applications in antioxidants, reinforced materials and nanomicrocarriers owing to their advantages of non-toxicity, environmental resistance, excellent thermal stability and biocompatibility [14]. Nanolignin is rich in active functional groups such as phenolic hydroxyl groups, alcohol hydroxyl groups, carboxyl groups, carbonyl groups, etc [15]. These functional groups will easily form composites with metal nanoparticles and improve the loading capacity of metal nanoparticles. Therefore, the formation of lignin-based nanocatalyst will open up a different perspective for expanding the high-value applications of lignin.

In our study, a green sustainable and recyclable nanocatalyst composite with high catalytic performance was prepared in an easy-to-operate method. Firstly, a facile and environmentally friendly approach was used to prepare the homogeneous and stable spherical lignin nanoparticles (LNPs). Subsequently, Pd nanoparticles were loaded into lignin nanoparticles to prepare Pd@LNPs nanocatalysts in a microwave oven. It turned out that Pd nanoparticles were uniformly and stably dispersed in the lignin nanoparticle matrix. Furthermore, the excellent and efficient catalytic properties of Pd@LNPs were exhibited by catalytic reduction of Cr(VI) and 4-nitrophenol as well as Suzuki C-C coupling reaction. The Pd@LNPs nanocatalysts prepared in this study have the advantages of excellent dispersion, great selectivity and high catalytic efficiency. It would have a great significance for the

development of the potential high-value of lignin and the progress in the field of nanocatalysts.

FIGURES



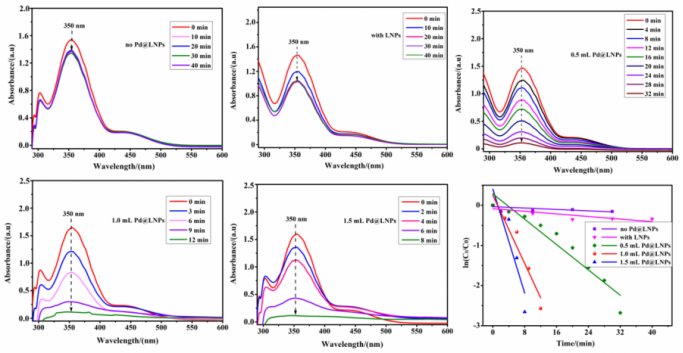


FIGURE 1

TEM image of Pd@LNPs nanocatalyst

Pd nanoparticles were uniformly and stably dispersed in the lignin nanoparticle matrix

FIGURE 2

Catalytic reduction of Cr(VI)

Time dependent UV-vis spectra for catalytic reduction of Cr(VI) treated with only formic acid, treated with LNPs solution, treated with Pd@LNPs nanocatalyst.

KEYWORDS

Pd@LNPs nanocatalyst | lignin nanoparticles | efficient catalytic properties | catalytic reduction

BIBLIOGRAPHY

[1] Zäch M.; Curr Opin Solid St M. 2006, 10, 132-43.
[2] Mohamed RM.; MAT SCI ENG R. 2012, 73, 1-3.
[3] Wang J.; Molecules. 2015, 20, 17070-92.
[4] Jin R.; NANOTECHNOL REV. 2012, 1, 31-56.
[5] Shokouhimehr M.; Applied Sciences. 2019, 9, 4183.
[6] Yang C.; J MATER CHEM. 2011, 21, 187-94.
[7] Ayad AI.; GREEN CHEM. 2019, 21, 6646-57.
[8] Creamer NJ.; CATAL TODAY. 2007, 128, 80-7.
[9] Yin Z.; CATAL SCI TECHNOL. 2014, 4, 4116-28.
[10] Li X.; CHEM ENG J. 2019, 372, 516-25.
[11] Qian, Y.; Green Chem. 2015, 17, 320-324.
[12] Dessbesell, L.; Renew. Sustain. Energy Rev. 2020, 123.
[13] Zhang Z.; Nanomaterials. 2021, 11, 1336.
[14] Henn, A.; World J. Microbiol. Biotechnol. 2019, 35, 125.
[15] Gillet, S.; Green Chem. 2017, 19, 4200–4233.