NJC

ROYAL SOCIETY OF CHEMISTRY

PAPER

View Article Online
View Journal | View Issue

Cite this: *New J. Chem.*, 2022, **46**, 9685

Distinguished performance of biogenically synthesized reduced-graphene-oxide-based mesoporous Au–Cu_2O/RGO ternary nanocomposites for sonocatalytic reduction of nitrophenols in water

Sushma Yadav,[a] Maruf Chauhan,[a] MercyKutty Jacob[b] and Priti Malhotra *[a]

In order to achieve a sustainable environment, the development of eco-friendly protocols for the production of noble metal catalysts has been the primary focus of major research. Ternary nanocomposites (TNCs) comprising Au–Cu_2O anchored on reduced graphene oxide (Au–Cu_2O/RGO) were synthesised employing a novel one-pot greener approach using sugarcane bagasse (SB) waste and Fehling's solution without engaging harmful chemicals as reagents and surfactants. In addition to the mild reducing capability of the polysaccharides present in SB, it also induces functionalization of RGO, avoiding aggregation of the reduced sheets and thereby providing *in situ* stabilization of Cu_2O. The sonocatalytic performance of biogenically synthesized Au–Cu_2O/RGO TNCs for reducing nitrophenols to the corresponding aminophenol in the presence of sodium borohydride ($NaBH_4$) as a reducing agent was estimated. TNCs showed high performance in the sonocatalytic reduction of 4-nitrophenols (4-NP), 2-nitrophenol (2-NP), and 3-nitrophenol (3-NP) with 88%, 72%, and 78% conversion within 90, 60, and 40 seconds, respectively. The sonocatalytic activity of Au–Cu_2O/RGO was enhanced compared to that of Cu_2O and Cu_2O/RGO due to the easier electron transfer process. The current work showcases a novel, eco-friendly, and benign protocol for the synthesis of nanocomposites (NCs) and simultaneously emphasises the exploration of decorated metal oxide as a nanocatalyst with high catalytic potential; compared to unanchored metal oxide nanoparticles (NPs), the supported NCs exhibit greater efficacy and ease of recovery.

Received 14th February 2022,
Accepted 16th April 2022

DOI: 10.1039/d2nj00745b

rsc.li/njc

Introduction

In recent memory, environmental pollution originating from global population growth has been somewhat overcome by the advent of green chemistry. From the perspective of sustainable and environmentally benign chemistry, there has been a growing demand for more sustainable and efficient protocols for the removal of organic pollutants. In particular, nitrophenols have a strongly toxic effect on methaemoglobin formation, causing cyanosis, confusion, unconsciousness, skin and eye irritation, abdominal pain, vomiting, and liver damage.[1,2] Owing to their high resistance to biodegradation and toxicity, nitrophenols are listed as priority control pollutants by the American Environmental Protection Agency (EPA).[3] Nitrophenols are broadly employed in various syntheses of final products and intermediates of agricultural chemicals, dyes, and pharmaceuticals, both in industry and in the laboratory.[4,5] Although various synthetic protocols have been reported for the catalytic reduction of nitrophenols to aminophenol,[6] an inexpensive, environmentally benign, non-toxic, one-pot synthesis protocol is still required for their sustainable and eco-friendly reduction. The products obtained after reduction, *i.e.*, aminophenols, are fine organic intermediates and precursors and can be utilized for the production of various agrochemicals, pharmaceuticals, pigments, polymers, dyes, and herbicides.[7]

Nowadays, various traditional protocols are being adopted for the elimination of nitrophenols from polluted water globally.[8] Although traditional methods play a dynamic role in monitoring water contamination, their high power consumption and tedious reactor design make them objectionable for bulk-scale production.[9,10] To overcome these disadvantages, attempts have been made by environmental scientists and researchers to explore sustainable, simple,

[a] *Department of Chemistry, Daulat Ram College, University of Delhi, Delhi-110007, India. E-mail: pritimalhotra21@gmail.com*
[b] *Department of Chemistry, Shri. Venkateswara College, University of Delhi, Delhi-110007, India*