Chapter 6
Green and Sustainable Nanomaterials:
Focus on Bio-Derived Carbon Nanomaterials and Low-Temperature Synthesis Routes to Reduce Environmental Impact

Apoorav Sharma
https://orcid.org/0009-0002-9966-7691
Lovely Professional University, India

Lovleen Marwaha
Lovely Professional University, India

Zahid Ahmed Thokker
https://orcid.org/0009-0002-6897-5835
Lovely Professional University, India

ABSTRACT

Green and sustainable nanomaterials are the new hopeful solutions on how to lighten the environmental impact of the sophisticated fuel purification process. The topic of this chapter is bio-derived carbon nanomaterials and low-temperature synthesis paths as alternatives to the traditional energy-intensive nanomaterial fabrication. Agricultural waste, algae, and industrial biowaste are biomass-based precursors that can provide renewable, cheap, and scalable sources of carbon. There is a focus on hydrothermal and microwave-assisted, and low-temperature chemical vapor deposition technologies, which consume less energy and contribute to fewer dangerous emissions. The chapter is a critical discussion of physicochemical properties,

DOI: 10.4018/979-8-3373-5966-3.ch006

functionalization strategies, and integration with the nanocomposites to desulfurize fuel efficiently. Green nanotechnology is also considered in terms of environmental, economic, and regulatory perspectives to emphasize the viability of the industry.

1. INTRODUCTION

The emissions of sulfur in fossil fuels have been one of the main causes of atmospheric pollution that poses great threats to the ecological systems as well as the health of humans. Sulfur oxides are also formed during fuel combustion and cause the formation of acid rain, fine particulate matter, and secondary aerosol that causes respiratory and cardiovascular diseases (Babich and Moulijn, 2003; Srivastava, 2012). Counter to this, strict global fuel quality standards have been implemented to restrict the levels of sulfur to ultra-low contents usually less than 10-15 ppm and mostly of transportation fuels (Song, 2003). Such regulatory requirements have aggravated the need to have highly efficient desulfurization processes that can eliminate refractory sulfur compounds like dibenzothiophene and alkylated derivatives of the same. The traditional hydrodesulfurization that is primarily used industrially works under harsh environments with high temperature and pressure, and needs huge amounts of hydrogen; therefore, it is energy consuming and economically challenging (Prins et al., 2006). More importantly, hydrodesulfurization does not have a high level of efficiency against the sterically hindered sulfur compounds, and thus, it requires further post-treatment processes. Other emerging technologies that include oxidative, extractive, and adsorptive desulfurization have been considered as alternative processes because of mild conditions of operation and high selectivity; nonetheless, the technologies rely heavily on the nanomaterials with designed surface characteristics (Rafiee et al., 2018; Li et al., 2016). The sustainability of such nanomaterials in the environment is, however, a critical issue since most of the synthesis processes have been associated with the use of harmful chemicals, large quantities of thermal energy and massive carbon release. The concept of the circular economy connecting biomass waste valorization, the production of eco-friendly nanomaterials, and the production of cleaner energy is also identified in Fig.1 below.

Related Content

“Catalyst in Biorefineries” Solution to Promote Environment Sustainability in India

Vikas Gupta (2020). *Advanced Catalysis Processes in Petrochemicals and Petroleum Refining: Emerging Research and Opportunities (pp. 139-171).*

www.irma-international.org/chapter/catalyst-in-biorefineries-solution-to-promote-environment-sustainability-in-india/238686

First Insights in the Estimation of the Petroleum Generation Potential of the Muerto Source Rock From el Cortado Outcrop, Northwestern Peru

Jose Alfonso Rodriguez-Cruzadoand Jorge Oré-Rodriguez (2024). *Sustainability Applied to Unconventional Oil and Gas Field Exploration and Development (pp. 123-145).*

www.irma-international.org/chapter/first-insights-in-the-estimation-of-the-petroleum-generation-potential-of-the-muerto-source-rock-from-el-cortado-outcrop-northwestern-peru/350480

Dual Role of Perovskite Hollow Fiber Membrane in the Methane Oxidation Reactions

Serbia M. Rodulfo-Baechler (2016). *Petrochemical Catalyst Materials, Processes, and Emerging Technologies (pp. 385-430).*

www.irma-international.org/chapter/dual-role-of-perovskite-hollow-fiber-membrane-in-the-methane-oxidation-reactions/146334

Advanced Catalysis and Processes to Convert Heavy Residues Into Fuels and High Value Chemicals

Feras Ahmed Alshehri, Saeed M. Al-Shihri, Mohammed C. Al-Kinany, Bandar M. Al-Hudaib, Abdulaziz F. Al-Ghashem, Ali A. Algarni, Sami D. Alzahrani, Peter P. Edwardsand Tiancun Xiao (2020). *Advanced Catalysis Processes in Petrochemicals and Petroleum Refining: Emerging Research and Opportunities (pp. 110-138).*

www.irma-international.org/chapter/advanced-catalysis-and-processes-to-convert-heavy-residues-into-fuels-and-high-value-chemicals/238685