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NANOTECHNOLOGY IN ADVANCED MATERIALS AND BIOFUEL SYSTEMS: A SUSTAINABLE APPROACH

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Abstract:

Nanotechnology has emerged as a transformative tool in the development of advanced materials and biofuel systems, offering innovative solutions to pressing sustainability challenges. This chapter explores the integration of nanostructured materials, nanoparticles, and nano-catalysts in enhancing the efficiency, performance, and environmental compatibility of biofuel production processes. Special emphasis is placed on the role of nanomaterials in improving feedstock conversion, reducing processing costs, and increasing energy yield. The chapter also examines the development of advanced composites, coatings, and functional materials enabled by nanotechnology to improve durability, thermal stability, and biodegradability, thus supporting a circular economy. Furthermore, it highlights case studies demonstrating successful industrial applications, lifecycle assessments, and techno-economic analyses of nanotechnology-enabled biofuel systems. By bridging material science innovations with renewable energy technologies, this sustainable approach aims to advance cleaner energy production and resource efficiency, aligning with global decarbonization and climate change mitigation goals.

Keywords: *Nanotechnology, Advanced materials, Biofuel systems, Nano-catalysts, Sustainable energy, Renewable feedstock, Biomass conversion, Energy efficiency, Circular economy, Green technology*

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