Chapter 6
Green Nanomaterials and Nanocomposites

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ABSTRACT

Green nanomaterials refer to those materials synthesized using environmentally benign processes, renewable resources, and minimal energy consumption, thereby aligning with principles of green their individual components. When these materials are produced using eco-friendly approaches, they are termed green nanocomposites. Together, green nanomaterials and nanocomposites form a critical domain that bridges the gap between advanced material science and environmental responsibility.The driving force behind the rise of green nanotechnology is the pressing need to reduce environmental degradation caused by conventional synthesis and manufacturing methods. Traditional techniques often involve toxic chemicals, high energy consumption, and unsustainable resource utilization. In contrast, green nanotechnology emphasizes the use of non-toxic precursors, renewable feedstocks,

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and energy-efficient synthesis methods. The eco-friendly synthesis of these materials, such as using biomass-derived carbon sources, further reduces their environmental footprint.

INTRODUCTION TO GREEN NANOMATERIALS AND NANOCOMPOSITES

Green nanomaterials refer to those materials synthesized using environmentally benign processes, renewable resources, and minimal energy consumption, thereby aligning with principles of green their individual components. When these materials are produced using eco-friendly approaches, they are termed green nanocomposites. Together, green nanomaterials and nanocomposites form a critical domain that bridges the gap between advanced material science and environmental responsibility.The driving force behind the rise of green nanotechnology is the pressing need to reduce environmental degradation caused by conventional synthesis and manufacturing methods. Traditional techniques often involve toxic chemicals, high energy consumption, and unsustainable resource utilization. In contrast, green nanotechnology emphasizes the use of non-toxic precursors, renewable feedstocks, and energy-efficient synthesis methods. The eco-friendly synthesis of these materials, such as using biomass-derived carbon sources, further reduces their environmental footprint. In addition, natural and biodegradable polymers, including cellulose, chitosan, and starch, have gained significant attention as green nanomaterials. These polymers are renewable, biodegradable, and non-toxic, making them ideal for producing sustainable nanocomposites.Green nanocomposites are hybrid materials that combine a biodegradable or bio-based matrix with nanoscale fillers to achieve enhanced mechanical, thermal, and barrier properties. These composites often incorporate natural nanofillers, such as nanocellulose, nanosilica, clay nanoparticles, and biochar, to create materials with high strength, lightweight characteristics, and improved functionality.Nanocarriers made from biodegradable polymers, such as chitosan and polylactic acid, are used to deliver r enhances their therapeutic potential. Green nanocomposites are also finding applications in the food industry for developing sustainable packaging materials that provide enhanced barrier properties, antimicrobial activity, and reduced environmental impact. In conclusion, green nanomaterials and nanocomposites represent a sustainable and promising approach to address the challenges of environmental degradation, resource scarcity, and industrial pollution. By harnessing eco-friendly synthesis methods and renewable resources, these materials offer innovative solutions across future.