



A BRIEF REVIEW ON PROPERTIES, APPLICATIONS, ADVANCES, AND FUTURE PROSPECTS OF POLYMER NANOCOMPOSITES

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ABSTRACT

Composites that have at least one phase with dimensions in nanometre are called nanocomposites. In recent years research into creating polymer-based composites for energy and structural purpose is becoming more and more popular due to their special high strength and lightweight characteristics. Nanocomposites has become one of the most widely used materials with significant applications in variety of fields, such as flexible batteries, higher power output batteries, lightweight sensors, photocatalysis and ability to make malignancies easier to identify and remove. Since nanomaterials have distinct physical and chemical characteristics form traditional strength fillers like carbon fibers and natural fibers, their use in polymer-based matrices for a variety of applications has grown significantly in recent years. Their potential is so great that they are useful in a wide range of fields, from biological application to packaging. Nonetheless, a number of researchers have been working consistently to enhance the mechanical characteristic of polymers through the use of various reinforcement techniques. This review examines matrix nanocomposites with an emphasis on the necessity of these materials, their processing methods, properties and some current finding regarding their structure, characteristic, and their uses.

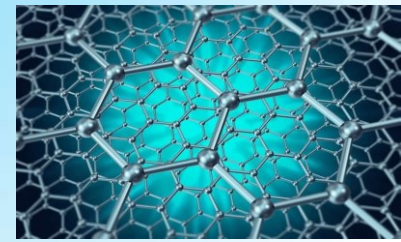


Figure 1: Nanocomposites

Keywords: Nanoparticles, Nanocomposites, Manufacturing, Nanocomposite Application

INTRODUCTION

Nanocomposites are advanced materials that integrate nanoscale fillers, such as carbon nanotubes, metal oxides, or polymeric nanofibers, into bulk matrices like polymers, metals, or ceramics. This combination enhances mechanical strength, thermal stability, and electrical conductivity, surpassing traditional composites. With applications in aerospace, automotive, electronics, biomedical engineering, and environmental remediation, nanocomposites are vital for developing lightweight, durable, and high-performance materials. Their role extends to energy storage and sustainability solutions, addressing modern technological challenges. By improving structural integrity and multifunctionality, nanocomposites have revolutionized material science. Ongoing research focuses on optimizing their synthesis and expanding applications, ensuring their continued impact across industries.

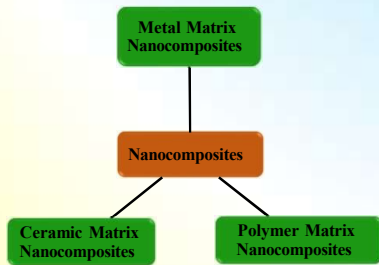


Figure 2: Type of Nanocomposites

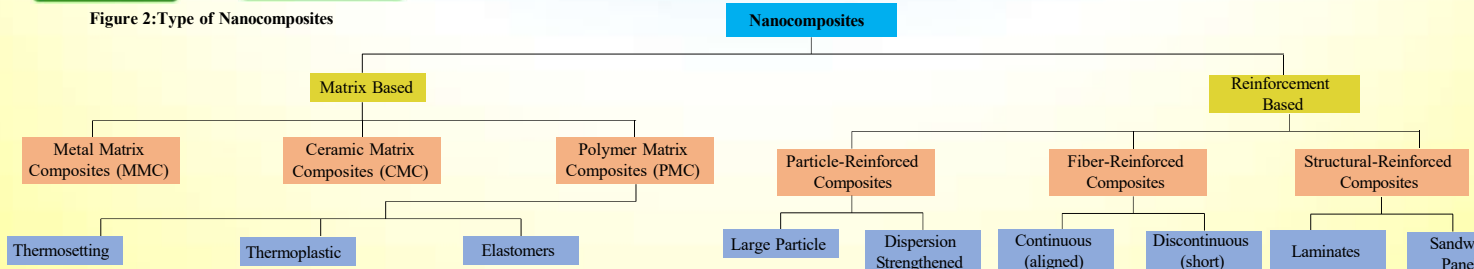
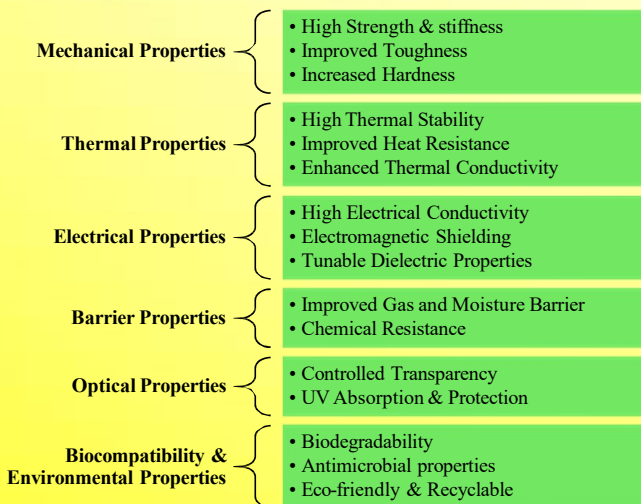


Figure 3: Classification of Nanocomposites[3]

PROPERTIES OF NANOCOMPOSITES



APPLICATIONS OF NANOCOMPOSITES



CONCLUSION

Nanocomposites have revolutionized material science by offering superior properties and a wide range of applications. Continued advancements in synthesis techniques and a deeper understanding of their interactions at the nanoscale will drive the future of nanocomposite technology, enabling innovative solutions across multiple disciplines. Nanocomposites represent a transformative class of materials with diverse applications across industries. Their enhanced mechanical, thermal, electrical, and barrier properties make them ideal for addressing complex challenges in healthcare, energy, environmental remediation, and aerospace. While significant progress has been made, further research is needed to address scalability, cost, and safety concerns. By leveraging emerging trends like hybrid composites and bio-based polymers, nanocomposites are poised to revolutionize material science and engineering in the coming decades.

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