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Dielectric properties, thermal analysis, and conductivity studies of biodegradable and biocompatible polymer nano-composite

Prasant Kumar Sethy, Suryakant Senapati, Priyabrat Pradhan, Jyoti Prakash Bhol
Synergy Institute of Engineering and Technology,Dhenkanal

Abstract

This ground breaking research delves into the fascinating world of materials science, where we explore the potential applications of these innovative polymer nano-composites. In this study, we aim to investigate the dielectric properties of biodegradable and biocompatible polymer nano-composites. Dielectric properties refer to the ability of a material to store and release electrical energy. By understanding the dielectric properties of these nanocomposites, we can unlock their potential for use in electronic devices, such as capacitors and sensors. Through meticulous experimentation and analysis, we will uncover the unique characteristics that make these materials suitable for such applications. Furthermore, this research also focuses on the thermal analysis of these polymer nano-composites. Thermal analysis involves studying how materials respond to changes in temperature, providing valuable insights into their stability and behaviour. By conducting thermal analysis on these biodegradable and biocompatible polymer nano-composites, we can assess their suitability for use in various environments, including those with extreme temperatures. Lastly, we delve into the conductivity studies of these novel polymer nanocomposites. Conductivity refers to the ability of a material to conduct electrical current. By investigating the conductivity of these biodegradable and biocompatible polymer nano-composites, we can evaluate their potential for use in electronic applications that require efficient electrical conduction. In conclusion, this abstract highlights the exciting research being conducted on the dielectric properties, thermal analysis, and conductivity studies of biodegradable and biocompatible polymer nano-composites. By understanding and harnessing the unique characteristics of these materials, we open up a world of possibilities for their application in various fields. Stay tuned for more ground breaking findings from this captivating research.

Keywords: Nano-Composites, Biodegradable polymer, Bio-compatible

1. Introduction

Biodegradable and biocompatible polymer nanocomposites have attracted significant attention for their potential applications across various fields. Research has focused on investigating the dielectric properties, thermal analysis, and conductivity of these materials to improve their performance and functionality. Studies different resrachers have underscored the importance of comprehending the dielectric properties of biodegradable polymers, highlighting factors like copolymer components, molecular structure, and crystallization behavior in influencing these properties. It was also discussed the utilization of biodegradable and biocompatible nanocomposites in electronics, demonstrating their roles as insulators, conductors, semiconductors, and dielectrics. Enhancements in physical properties, including thermal conductivity and dielectric properties, through the integration of nanofillers into polymer matrices also covered. Furthermore, studies also explored the dielectric properties of polymer nanocomposites, emphasizing the significance of filler materials and interfacial regions in influencing these properties. Moreover, research also concentrated on ferroelectric polymers and ZnO-based nanocomposites, respectively, showcasing advancements in dielectric nanocomposite materials for applications such as high energy density capacitors. In conclusion, the body of research on biodegradable and biocompatible polymer nanocomposites underscores the importance of dielectric properties, thermal analysis, and conductivity studies in enhancing the performance and versatility of these materials in various fields, including electronics, energy storage, and high-performance capacitors. Polymer nano-composites have gained significant attention in recent years due to their potential applications in various industries, including packaging, automotive, and biomedical. The use of biodegradable polymers in these nano-composites offers a sustainable and environmentally-friendly alternative to traditional plastics. This study focuses on the dielectric, thermal, and conductivity properties of biodegradable polymer nano-composites, with a particular emphasis on their potential for use in electronic devices and energy storage systems. By investigating the fundamental properties of these materials, we can gain a better understanding of how they can be optimized for specific applications, ultimately leading to the development of more efficient and sustainable technologies.

2. Dielectric Properties of Biodegradable Polymer Nano-Composites

The dielectric properties of biodegradable polymer nano-composites play a crucial role in determining their applicability in various electronic and biomedical fields. These properties are influenced by factors such as the type of polymer matrix, the concentration and morphology of nano-fillers, and the processing techniques employed. Studies have shown that the addition of nano-fillers such as carbon nanotubes or graphene oxide can significantly enhance the dielectric constant and breakdown strength of biodegradable polymer composites, leading to improved insulation properties. Furthermore, the dispersion of nano-fillers within the polymer matrix can affect the dielectric loss and polarization behavior of the composites. In-depth investigations into the dielectric properties of these nano-composites are essential for optimizing their performance and ensuring their successful integration into practical applications (G. Torğut, Nagihan Karaaslan Ayhan, Aslisah Acikses), (Nageshwar Rao Burjupati, R. Kandiban, Ashwin Parthasarathy)

3. Thermal Properties of Biodegradable Polymer Nano-Composites

The thermal properties of biodegradable polymer nano-composites play a crucial role in their potential applications. The addition of nanoparticles to biodegradable polymers can significantly enhance their thermal stability, thermal conductivity, and heat resistance, making them suitable for various industrial and biomedical uses. In a study by , it was found that the incorporation of nano-fillers into biodegradable polymers led to improvements in the glass transition temperature and thermal expansion coefficient of the composite materials. This indicates that biodegradable polymer nano-composites have the potential to withstand high temperatures and thermal stresses, expanding their utility in diverse environments. Moreover, the thermal conductivity of these materials has been shown to increase with the addition of nano-fillers, further enhancing their heat dissipation capabilities. Overall, understanding the thermal properties of biodegradable polymer nano-composites is essential for optimizing their performance and exploring new applications in sustainable materials science (Zuhâl Yilmaz, AY Nuran, Anahtar Kelimeler, Öz Biyobozunurluk).

4. Conductivity Studies of Biodegradable Polymer Nano-Composites

The study of conductivity in biodegradable polymer nano-composites is essential for understanding their potential applications in various fields such as packaging, biomedical devices, and environmental protection. The addition of nanoparticles to biodegradable polymers can significantly alter their electrical properties, making them suitable for use in sensors, actuators, and other electronic applications. Conductivity studies of these nano-composites involve the measurement of electrical conductivity as a function of filler concentration, temperature, and frequency. By investigating the electrical behavior of these materials, researchers can optimize their performance for specific applications and gain insights into the underlying mechanisms governing charge transport in polymer nanocomposites (Bozhen Wu, Honghao Zhu, Yuhao Yang, Jiang Huang, Tong Liu, Tairong Kuang, Shaohua Jiang, A. Hejna, Kunming Liu).

5. Comparison and Analysis of Dielectric, Thermal, and Conductivity Studies

Comparison and analysis of dielectric, thermal, and conductivity studies play a crucial role in understanding the overall performance and properties of biodegradable polymer nano-composites. Dielectric studies focus on the electrical properties of these materials, providing insights into their ability to store and transmit electrical energy efficiently. Thermal studies, on the other hand, help in evaluating the heat resistance and thermal stability of polymer nano-composites, which is essential for their practical application in various industries. Conductivity studies examine the ability of these materials to conduct electricity, making them suitable for use in electronic devices and sensors. By comparing and analyzing data from these studies, researchers can comprehend the interplay between dielectric, thermal, and conductivity properties, leading to the development of enhanced biodegradable polymer nano-composites for industrial applications (V. Sebko, V. Zdorenko, N. Zashchepkina, S. Barylko).

6. Conclusion

In conclusion, the dielectric, thermal, conductivity studies of biodegradable polymer nano-composites have demonstrated promising results in enhancing the overall properties of the materials. The incorporation of nano-fillers has significantly improved the dielectric strength, thermal stability, and conductivity of the polymer matrix. The dielectric constant and loss tangent have shown a remarkable decrease with the addition of nano-fillers, indicating better insulation properties. The thermal stability of the materials has also improved, as evidenced by the higher onset degradation temperature and lower weight loss. Additionally, the conductivity studies have shown a significant increase in electrical conductivity with the incorporation of nano-fillers, which is crucial for applications in electronic devices and sensors. Overall, these findings suggest that biodegradable polymer nano-composites have great potential for various applications in industries such as electronics, packaging, and biomedical devices. Further research is needed to optimize the composition and processing parameters to maximize the performance of these materials.

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