

Bioresorbable Polymers: Advanced Materials for Biomedical and Sustainable Applications

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Editorial

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ABSTRACT

Bioresorbable polymers are a unique class of materials that degrade naturally within biological environments, eliminating the need for surgical removal after fulfilling their intended function. These polymers have gained considerable attention in biomedical applications such as drug delivery systems, tissue engineering, and temporary implants. Their degradation into non-toxic byproducts makes them highly suitable for clinical use. Additionally, bioresorbable polymers are increasingly explored in environmentally sustainable applications due to their biodegradability. This article provides an overview of the types, properties, degradation mechanisms, applications, advantages, and challenges of bioresorbable polymers, along with recent advances in the field.

Keywords

Bioresorbable Polymers, Biodegradable Materials, Drug Delivery, Tissue Engineering, Biomaterials, Medical Implants

INTRODUCTION

Bioresorbable polymers, also known as biodegradable polymers, are materials capable of breaking down into biologically acceptable byproducts when exposed to physiological conditions. Unlike permanent implants, these materials gradually degrade and are absorbed or excreted by the body.

The growing demand for minimally invasive treatments and environmentally friendly materials has accelerated research in this field. Bioresorbable polymers are particularly valuable in medical applications where temporary support is required, such as sutures, stents, and scaffolds for tissue regeneration^[1].

TYPES OF BIORESORBABLE POLYMERS

Natural bioresorbable polymers include proteins and polysaccharides such as collagen, gelatin, chitosan, and starch. These materials exhibit excellent biocompatibility and bioactivity but may have limited mechanical strength.

Synthetic bioresorbable polymers are widely used due to their tunable properties. Common examples include:

Poly(lactic acid) (PLA)

Poly(glycolic acid) (PGA)

Poly(lactic-co-glycolic acid) (PLGA)

Polycaprolactone (PCL)

These polymers allow precise control over degradation rates and mechanical properties. Composite systems combine natural and synthetic materials to enhance both biological performance and structural integrity^[2].

PROPERTIES OF BIORESORBABLE POLYMERS

These polymers must not induce adverse immune responses and should support cell growth and tissue integration. The degradation rate should match the rate of tissue healing or drug release requirements. Adequate mechanical properties are essential,

especially in load-bearing applications such as orthopedic implants. They should be easily fabricated into desired shapes, including fibers, films, and scaffolds.

DEGRADATION MECHANISMS

Bioresorbable polymers degrade through several mechanisms:

Hydrolytic Degradation, Breakdown of polymer chains due to reaction with water. Enzymatic Degradation, Enzymes in the body catalyze polymer degradation. Oxidative Degradation: Reactive oxygen species contribute to polymer breakdown. The degradation products are typically metabolized and eliminated from the body ^[3].

BIOMEDICAL APPLICATIONS

Bioresorbable polymers are extensively used for controlled drug release. Drugs are encapsulated within the polymer matrix and released as the material degrades. These polymers serve as scaffolds that support cell growth and tissue regeneration. They gradually degrade as new tissue forms. Absorbable sutures made from bioresorbable polymers eliminate the need for removal after healing. Temporary implants such as screws and pins made from bioresorbable polymers provide structural support during healing and then degrade naturally. Bioresorbable stents are used to keep blood vessels open and gradually dissolve after restoring normal function ^[4].

ADVANTAGES OF BIORESORBABLE POLYMERS

Elimination of secondary surgery for implant removal. Reduced long-term complications. Biodegradability and environmental sustainability. Tunable degradation and mechanical properties . Compatibility with drug delivery systems

RECENT ADVANCES AND FUTURE PERSPECTIVES

Recent developments include the design of smart bioresorbable polymers with stimuli-responsive behavior and enhanced mechanical properties. Nanotechnology integration has improved drug delivery efficiency and targeting. Advances in 3D printing have enabled the fabrication of customized implants and scaffolds. Additionally, research into environmentally friendly bioresorbable plastics is expanding their use beyond biomedical applications. Future directions focus on improving material performance, achieving precise control over degradation, and developing multifunctional systems for advanced therapeutic applications ^[5].

CONCLUSION

Bioresorbable polymers represent a significant advancement in both biomedical and sustainable material science. Their ability to degrade safely within the body makes them ideal for temporary medical applications, reducing the need for additional surgical procedures. While challenges such as mechanical limitations and controlled degradation remain, ongoing research continues to enhance their properties and expand their applications. With continued innovation, bioresorbable polymers are expected to play a vital role in the future of medicine and environmentally sustainable technologies.

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CONFLICT OF INTEREST

None.

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