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# Research Progress on Degradable Textile Materials Based on Renewable Resources

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## Article

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## ABSTRACT

*Degradable textile materials based on renewable resources have become a research hotspot in the field of textile materials science and engineering at home and abroad due to their significant advantages in sustainable development, recycling, and environmental friendliness. This review summarizes the types and preparation methods of renewable resource-based biodegradable textile materials. It further discusses their structural characteristics, performance regulation mechanisms, and recent advances in applications across apparel, home textiles, medical care, and industrial sectors. The resource characteristics, molecular structures, modification strategies, and their effects on degradation and mechanical properties of different raw materials such as natural cellulose, protein polymers, polysaccharides, polylactic acid, etc. The degradation mechanism, environmental adaptability, and life cycle assessment results of biodegradable textile materials; Finally, the current technological bottlenecks, such as high production costs, insufficient performance stability, and poor controllability of degradation rates, were analyzed, and future development trends were proposed, including green synthesis, functional modification, composite design, and intelligent applications.*

## KEYWORDS

*renewable resources, degradable textile materials, cellulose, polylactic acid, future development trends*

## INTRODUCTION

The global textile industry has experienced sustained rapid development over the past few decades. The continuous expansion of production and consumption scales has significantly driven economic growth, but it has also been accompanied by intensified resource consumption and environmental pressure. Among traditional textile raw materials, petroleum-based synthetic fibers occupy a prominent position, offering

advantages such as low cost, stable performance, and wide applicability during production and use [1]. However, these synthetic fibers are generally non-degradable and are often landfilled or incinerated after use. This disposal method not only represents significant resource waste but also releases large amounts of greenhouse gases and harmful compounds during degradation, which poses long-term adverse effects on ecosystems and human health [2]. Statistics indicate that millions of tons of textile waste enter landfills or the natural environment annually worldwide, with a considerable portion converting into microplastic particles that infiltrate water bodies, soil, and the food chain, posing potential ecological risks [3]. Meanwhile, the reserves of non-renewable resources such as petroleum are declining year by year, further prompting research into the development and utilization of sustainable raw materials.

Against this backdrop, degradable textile materials based on renewable resources have gradually gained attention from both academia and industry [4]. These materials, primarily derived from natural cellulose, proteins, polysaccharides, and bio-based polyesters, can degrade into non-toxic products (e.g., carbon dioxide, water, and biomass) under suitable natural conditions or specific treatment environments through microbial metabolism, enzymatic catalysis, or hydrolysis, thereby effectively reducing environmental pollution. The classification of renewable resource-based degradable textile materials encompasses both natural structural polymers and polymers synthesized from bio-derived monomers. The classification reflects both the renewable origin of the materials and their degradable end-of-life characteristic. Natural polymers generally require minimal processing to retain their fiber form, whereas bio-based synthetic polymers undergo substantial chemical conversion from a bio-derived monomers. Compared with traditional petroleum-based materials, renewable resource-based degradable textile materials not only exhibit environmental friendliness but also hold significant strategic importance in sustainable resource utilization, circular economy construction, and green manufacturing [5]. In recent years, advances in green chemical synthesis technologies, functional modification methods, and advanced processing techniques have significantly improved the mechanical properties, durability, and application adaptability of these materials. Their application prospects in apparel, home textiles, medical and health, and even industrial technology sectors have expanded increasingly, providing new pathways and opportunities for the global textile industry to transition toward low-carbon, environmentally friendly, and circular development [6].

## CLASSIFICATION AND RAW MATERIAL CHARACTERISTICS OF RENEWABLE RESOURCE-BASED DEGRADABLE TEXTILE MATERIALS

### Natural Cellulosic Materials

Cellulose is the most abundant natural organic polymer, widely present in plant tissues such as cotton, linen, ramie, bamboo, and wood, accounting for a large proportion of plant cell walls. Cellulose molecules consist of D-glucose units linked by  $\beta$ -1,4-glycosidic bonds, featuring an alternating distribution of highly ordered crystalline regions and relatively loose amorphous regions. This semi-crystalline structure contributes to the material's excellent tensile strength and dimensional stability while simultaneously providing good hygroscopicity and biocompatibility, making it comfortable, breathable, and skin-friendly in textile applications [7]. The preparation of cellulose-based degradable textile materials mainly includes physical processing and chemical regeneration. Physical processing involves ginning, combing, spinning, and other steps, preserving the natural structure and properties of cellulose. Chemical regeneration methods, such as the viscose process and Lyocell process, obtain more uniform and high-strength fiber morphologies through dissolution and regeneration [8]. The structure and processing of natural cellulose are shown in Figure 1:

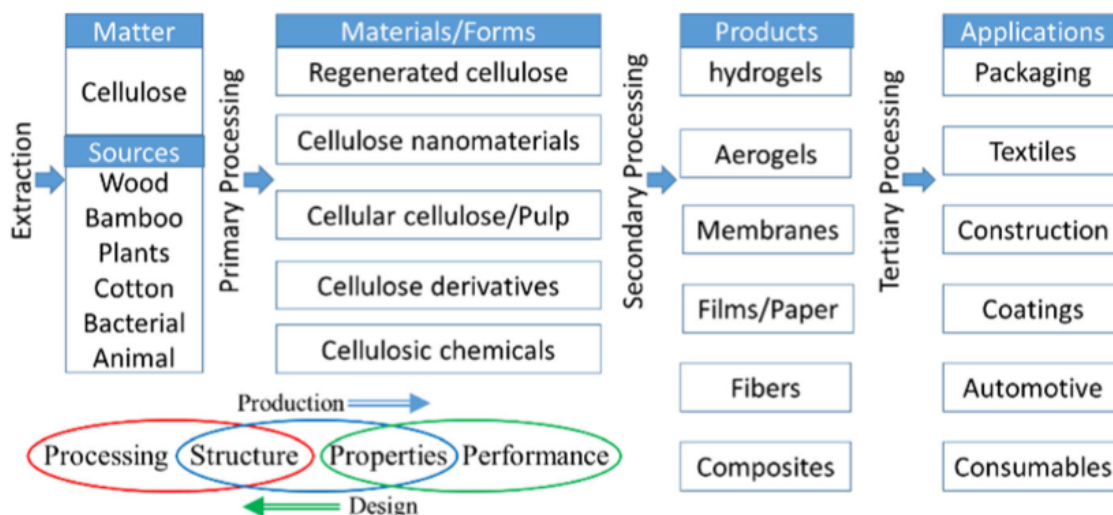


Figure 1. Structure and Processing of Natural Cellulose

To enhance stability and durability under humid and hot conditions, molecular modification techniques such as etherification, esterification, and graft polymerization can be employed to improve hygroscopicity,

dyeability, and wear resistance while maintaining biodegradability. In natural environments or composting conditions, cellulose fibers can be gradually hydrolyzed into glucose by cellulase, ultimately metabolized by microorganisms into carbon dioxide and water, achieving environmentally friendly degradation.

### Protein-Based Polymer Materials

Protein-based fibers include naturally derived animal fibers (e.g., silk and wool) and artificially prepared plant protein fibers (e.g., corn protein fibers and soybean protein fibers). Protein molecular chains are composed of amino acid units linked by peptide bonds, with active functional groups (e.g., amino, carboxyl, and hydroxyl) in their polypeptide chain structures. These groups confer good dyeability, hygroscopicity, and a soft, delicate handle to the fibers, along with high biodegradability. During natural degradation, proteases cleave the peptide bonds in polypeptide chains, decomposing them into amino acids or small-molecule peptides for further utilization by microorganisms. Silk fibers exhibit excellent luster and handle but relatively low light resistance and wet strength; wool fibers have good crimp elasticity and warmth retention but are prone to felting [9]. The classification of commonly used polyelectrolyte materials in protein separation is shown in Figure 2:

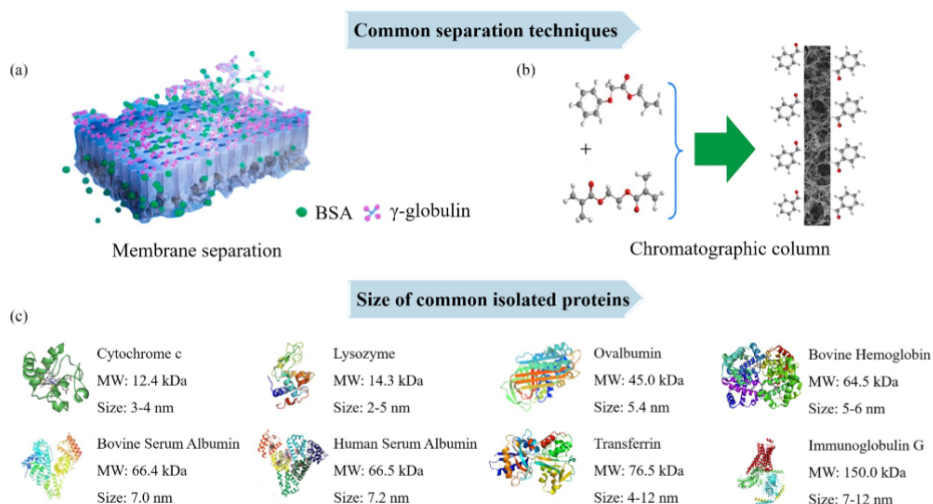


Figure 2. Classification of commonly used polyelectrolyte materials in protein separation. a: Membrane separation; b: Chromatographic column; c: Size of co isolated proteins

Plant protein fibers are mostly prepared via solution spinning and can be blended or modified at the molecular structure level to improve wet strength and durability. The mechanical properties and stability of protein fibers can be effectively enhanced through blending with other degradable polymers, crosslinking treatment, or nano-filler reinforcement, thereby expanding their applications in apparel, home textiles, and functional textiles [10].

### Polysaccharide-Based Materials

Polysaccharide-based polymers, such as starch and chitosan, are another important class of renewable resources. Starch, mainly derived from crops such as corn, potatoes, and cassava, consists of amylose and amylopectin, with a molecular structure rich in hydroxyl groups that impart hydrophilicity and degradability. However, native starch faces limitations in textile applications, including high brittleness, poor mechanical properties, and excessive hygroscopicity, requiring modification via esterification, etherification, or melt blending to improve toughness and dimensional stability. Chitosan, a product of chitin deacetylation derived from crustaceans (e.g., shrimp and crabs), has a cationic molecular chain that can interact with the negative charges of bacterial cell membranes, exhibiting excellent antibacterial properties and biocompatibility [11].

The targeted delivery system of polysaccharide based materials is shown in Figure 3:

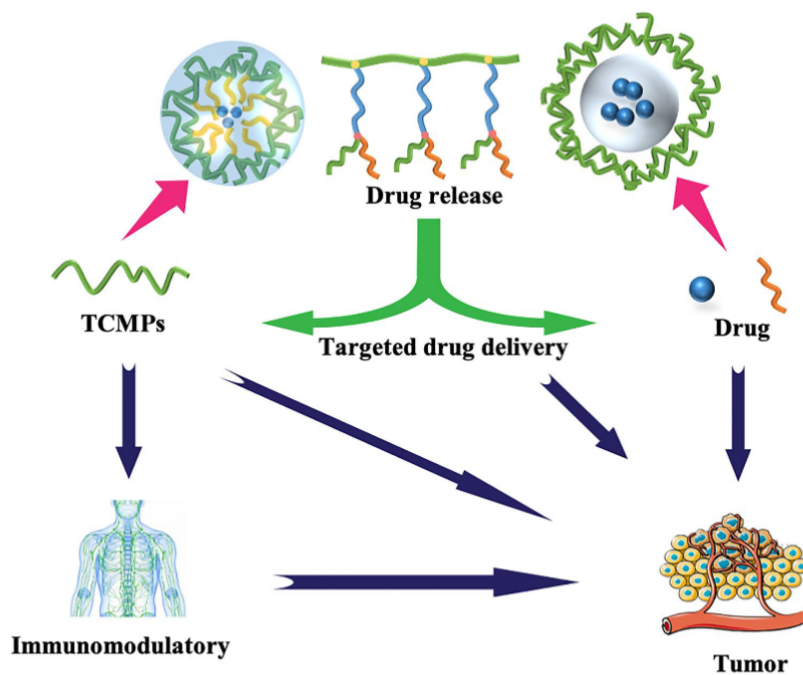


Figure 3. Targeted delivery system of polysaccharide-based materials

Chitosan fibers are commonly used in medical protective fabrics, functional home textiles, and wound dressings. During natural degradation, polysaccharide molecules are easily decomposed into monosaccharides by hydrolases secreted by microorganisms, which then enter the biological metabolic cycle without harmful residues, aligning with the requirements of green and sustainable development [12].

**Bio-Based Polyester Materials**

Bio-based polyesters, particularly polylactic acid (PLA), are among the most widely used renewable resource-based polymer fiber materials. Unlike the directly extracted or regenerated natural polymers discussed previously (cellulose, protein, polysaccharides), bio-based polyesters are synthetic polymers. They are produced via chemical polymerization of monomers (e.g., lactic acid) derived from renewable biomass, justifying their classification as a distinct category: Bio-Based Synthetic Fibers from Renewable Resources. PLA is derived from starch-rich crops such as corn, cassava, and sugar beets, which undergo saccharification and fermentation to produce lactic acid, followed by polycondensation or ring-opening polymerization of cyclic dimers to form the polymer [13]. The common biobased polyester materials are shown in Figure 4:

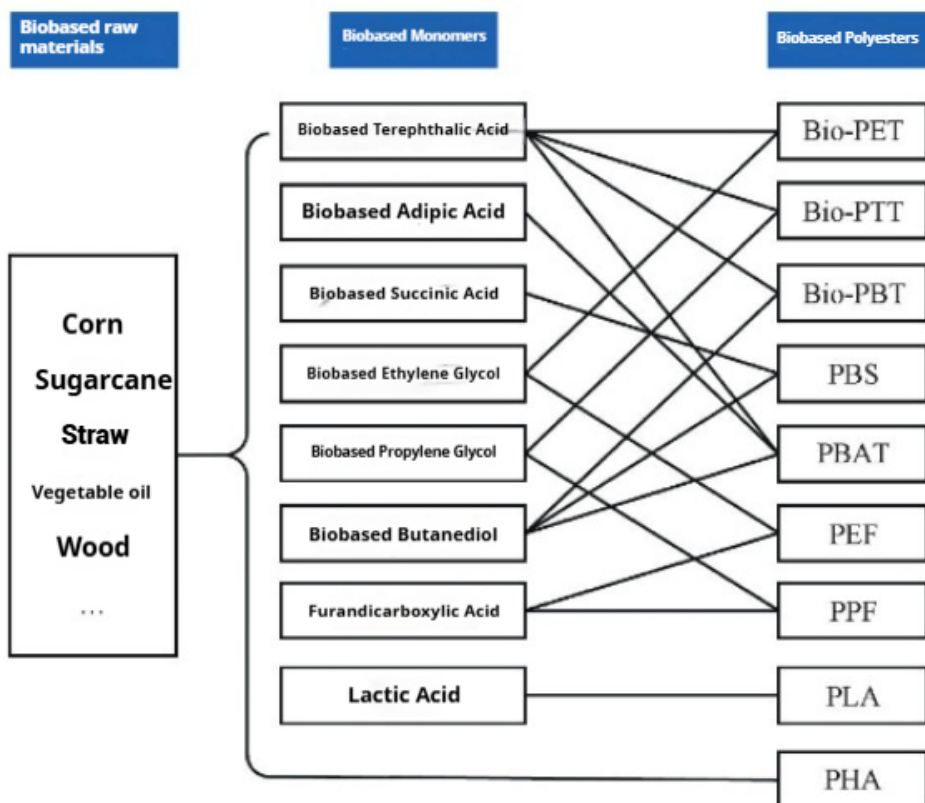


Figure 4. Common biobased polyester materials

## PREPARATION AND MODIFICATION TECHNOLOGIES

### Physical Modification Methods

Physical modification refers to techniques that improve material structure and properties through physical means without altering the chemical composition of polymers. Common physical modification methods for renewable resource-based degradable textile materials include blend spinning, nano-filling, and heat treatment. Blend spinning involves mixing degradable polymers such as PLA, polycaprolactone (PCL), and poly(butylene adipate-co-terephthalate) (PBAT) in specific proportions, followed by melt or solution spinning, which significantly enhances the toughness and elongation of PLA and mitigates its brittleness. Nano-filling utilizes reinforcing fillers such as nano-cellulose, graphene oxide, and clay nanosheets to improve fiber mechanical strength, wear resistance, and thermal stability, while imparting additional functions such as barrier properties, antibacterial activity, or conductivity. Heat treatment regulates the crystallinity and orientation of materials by controlling heating temperature and duration, thereby improving dimensional stability and heat resistance. Physical modification processes are simple, highly controllable, and do not introduce harmful chemical residues, making them valuable in green textile processing [14].

### Chemical Modification Methods

Chemical modification is an important approach to improve material properties by introducing specific functional groups into polymer chains via chemical reactions. Common methods include graft polymerization, crosslinking, esterification, and etherification. For example, the hydroxyl groups in cellulose molecules readily undergo esterification or etherification reactions; the introduction of hydrophobic groups significantly reduces hygroscopicity and improves wearing performance and dimensional stability. Protein fibers can be crosslinked to enhance intermolecular bonding, improving water resistance and strength. For polyesters such as PLA, chain extenders can be used to increase molecular weight and chain regularity, thereby enhancing heat resistance, mechanical strength, and melt processability. Chemical modification not only improves fiber mechanical and thermal properties but also imparts functions such as UV resistance, antibacterial activity,

and flame retardancy. However, reaction conditions and reagent selection must be carefully controlled to minimize environmental pollution and maintain biodegradability [15].

### **Biotechnological Modification**

Biotechnological modification utilizes biological methods (e.g., microorganisms, enzymes, or genetic engineering) to regulate the molecular structure and optimize the properties of renewable resource-based materials. Genetic engineering of lactic acid bacteria or other metabolic strains can significantly improve the yield and optical purity of bio-based monomers (e.g., lactic acid, succinic acid), providing high-quality raw materials for the synthesis of high-performance polymers [16]. Enzymatic modification employs specific enzymes (e.g., lipases, transferases, cellulases) to catalyze reactions on material surfaces or molecular chains under mild conditions, enabling the introduction of specific functional groups or changes in molecular chain arrangement to improve hydrophilicity, dyeability, softness, or degradation rate. Compared with traditional chemical methods, biotechnological modification offers advantages such as high selectivity, mild conditions, and environmental friendliness, contributing to the development of green textile processing. However, this method faces challenges in industrial application, including high enzyme costs, insufficient stability, and low reaction efficiency, which require resolution through enzyme engineering and process optimization [17].

### **Modification Effects on Degradation and Mechanical Properties**

Physical, chemical, and biotechnological modification strategies are widely employed to improve the performance stability of renewable resource-based textile materials. These approaches mainly aim to enhance mechanical properties and regulate degradation behavior. The effects of key modifications on the performance of different material classes are summarized below:

#### **Natural Cellulosic Materials (e.g., Cotton, Regenerated Cellulose):**

**Chemical Modification (Etherification, Esterification):** These reactions introduce hydrophobic groups to the cellulose molecule.

**Mechanical Effect:** They improve dimensional stability and wearing performance.

**Degradation Effect:** The introduction of hydrophobic groups can potentially slow the degradation rate by limiting water and enzyme access, while the material ultimately maintains biodegradability.

#### **Protein-Based Polymer Materials (e.g., Silk, Wool, Plant Proteins):**

**Chemical Modification (Crosslinking Treatment):** This treatment enhances intermolecular bonding.

**Mechanical Effect:** It substantially improves the material's water resistance and mechanical strength, directly mitigating the inherent challenge of low wet strength.

**Physical Modification (Blending with other degradable polymers, Nano-filler reinforcement):**

**Mechanical Effect:** These methods effectively enhance the overall mechanical properties, wet durability, and thermal stability of the protein fibers.

**Degradation Effect:** Blending can adjust the overall degradation profile, while nano-fillers may influence the accessibility of proteases, thereby regulating the degradation rate.

**Polysaccharide-Based Materials (e.g., Starch):**

**Chemical/Physical Modification (Esterification, Etherification, Melt Blending):**

**Mechanical Effect:** These modifications are essential for significantly improving the material's toughness, flexibility, and dimensional stability, directly addressing native starch's high brittleness and poor mechanical properties.

**Degradation Effect:** Modifying the structure can modulate the accessibility of hydrolases, thereby controlling the degradation rate.

**Bio-Based Polyester Materials (e.g., Polylactic Acid, PLA):**

**Physical Modification (Blend Spinning with PCL or PBAT):**

**Mechanical Effect:** This strategy significantly enhances the toughness, elongation, and impact resistance of the fiber, mitigating PLA's primary stability bottleneck of inherent brittleness.

**Chemical Modification (Chain Extenders):**

**Mechanical Effect:** These increase molecular weight and chain regularity, enhancing heat resistance, mechanical strength, and melt processability.

**Degradation Effect:** Increasing crystallinity and chain regularity (often a side effect of mechanical property enhancement) generally slows the hydrolysis and enzymatic degradation rate of PLA by impeding the penetration of water and enzymes into the material structure.

## PROPERTIES AND DEGRADATION MECHANISMS

### Mechanical Properties

The mechanical properties of renewable resource-based degradable fibers are influenced by multiple factors, including molecular chain chemical structure, crystallinity, orientation, and subsequent modification methods. Cellulose fibers exhibit high tensile strength and wear resistance due to strong intermolecular hydrogen bonding but poor elastic recovery, tending to undergo permanent deformation under repeated bending or compression. PLA fibers offer good dimensional stability and chemical resistance but high brittleness, making them prone to fracture under high stress or low temperatures. Protein fibers such as silk and wool are soft and skin-friendly but exhibit low wet strength, with performance degradation in humid environments [18].

To directly address these critical stability issues—a key technological bottleneck—specific modification strategies are analytically reviewed here:

**Overcoming Brittleness in Starch (Polysaccharides):** Native starch inherently faces limitations in textile applications, including high brittleness and poor mechanical properties. This is actively overcome by chemical and physical modifications such as esterification, etherification, or melt blending, which are essential for significantly improving toughness, flexibility, and dimensional stability, thereby making the material viable for high-performance textile applications.

**Enhancing Wet Strength and Stability in Protein Fibers:** The inherent stability challenge of silk and wool is their low wet strength and performance degradation in humid environments. This is directly mitigated through crosslinking treatment (a chemical modification), which enhances intermolecular bonding to substantially improve the material's water resistance and mechanical strength. Furthermore, blending with other degradable polymers or utilizing nano-filler reinforcement effectively enhances the overall mechanical properties, wet durability, and thermal stability of the protein fibers.

**Mitigating Brittleness in Polylactic Acid (PLA):** The inherent brittleness of PLA is a primary stability bottleneck. This is commonly solved by blend spinning (a physical modification) with ductile polymers like polycaprolactone (PCL) or poly(butylene adipate-co-terephthalate) (PBAT) to significantly enhance the toughness, elongation, and impact resistance of the fiber, mitigating its tendency to fracture under stress. To

balance mechanical performance, composite design strategies are frequently adopted. For example, blending PLA with PCL improves toughness, interweaving cellulose and protein fibers enhances strength and comfort, and incorporating nano-fillers mechanical stability [19]. Through rational design and optimization, performance complementarity can be achieved to a certain extent, improving material adaptability in textile applications.

### **Degradation Mechanisms**

The degradation of renewable resource-based degradable fibers typically involves multiple mechanisms, including hydrolysis, enzymatic degradation, and photo/thermal degradation. Cellulosic materials are primarily degraded by cellulase, which cleaves  $\beta$ -1,4-glycosidic bonds in molecular chains, gradually breaking them down into glucose. The degradation process typically begins in the less ordered amorphous regions of the cellulose structure, which are more accessible to enzymes and water, before proceeding to the highly ordered crystalline regions, which degrade much more slowly. Protein fibers are hydrolyzed by proteases to form amino acids or small-molecule peptides, which are then metabolized by microorganisms. Specifically, proteases (e.g., keratinase for wool/silk) catalyze the cleavage of peptide bonds (amide bonds) within the polypeptide chains. Similar to cellulose, the rate of enzymatic degradation is influenced by the polymer's conformation; for instance, the degradation of silk is faster in the less crystalline, amorphous regions, and is slowed by tightly packed crystalline  $\beta$ -sheets.

For polyesters such as PLA, degradation initially involves the hydrolysis of ester bonds, producing low-molecular-weight lactic acid or oligomers, which are further decomposed into carbon dioxide and water by microorganisms. The degradation rate of PLA is significantly affected by its crystallinity and chain orientation, with amorphous regions degrading much faster due to easier penetration by water and enzymes. Degradation rate is influenced by various environmental factors: increased temperature accelerates molecular motion and reaction rates; higher humidity favors hydrolysis; pH changes can promote or inhibit enzyme activity; and different microbial enzyme systems significantly affect degradation efficiency [20].

### **Environmental Adaptability and Life Cycle Assessment**

Environmental adaptability is a key indicator of the practical application value of degradable textile materials. Life cycle assessment (LCA) studies have shown that renewable resource-based materials have significantly

lower carbon emissions during raw material acquisition compared to petroleum-based synthetic fibers, with negative carbon effects achievable through the utilization of agricultural waste. During the use phase, these materials generally maintain good stability, meeting wearing and functional requirements. In the disposal phase, their degradability significantly reduces solid waste accumulation and microplastic release risks, exerting positive environmental impacts.

However, some materials still incur high energy consumption during preparation and processing, and certain chemical modification steps may introduce environmental burdens [21]. Future efforts should focus on optimizing production processes, integrating renewable energy, and adopting green chemical technologies to further reduce carbon footprints, thereby enhancing overall environmental friendliness and sustainable development potential.

## **APPLICATION FIELDS AND INDUSTRIALIZATION PROGRESS**

### **Apparel and Home Textiles**

In the apparel and home textile sectors, renewable resource-based degradable fibers are increasingly accepted by consumers and brands due to their environmental friendliness and comfort. Fibers such as PLA, Lyocell, and bamboo fiber, with excellent breathability, hygroscopicity, and soft handle, are used in high-end fashion, intimate apparel, sportswear, and bedding. Lyocell fibers, produced via an environmentally friendly solvent recycling process, offer high strength, luster, and biodegradability. Bamboo fibers, inherently antibacterial and breathable, are particularly suitable for summer apparel and home textile products [22].

Functional modification technologies, including UV-resistant coatings and antibacterial or anti-mite treatments, can significantly improve material performance by imparting UV protection, antibacterial properties, and antistatic behavior. These high-performance degradable materials not only meet dual demands for comfort and durability but also align with sustainable consumption trends, promising a significant share in the mid-to-high-end market. However, despite performance improvements, their generally high production costs compared to petroleum-based fibers currently restrict their mass-market penetration, making them primarily a premium, niche offering in this sector.

## Medical and Health

In the medical and health field, renewable resource-based degradable fibers are widely used in disposable medical products and protective equipment due to their good biocompatibility, non-toxic degradation products, and excellent processability. Chitosan fibers, with their cationic properties and natural antibacterial activity, are used in wound dressings, surgical sutures, and antibacterial masks, inhibiting bacterial growth and promoting wound healing. PLA nonwovens, characterized by light weight, moderate strength, and controllable degradation cycles, are extensively applied in medical protective clothing, surgical gowns, and medical masks. After use, they can be degraded via industrial composting or in natural environments, avoiding secondary environmental pollution from medical waste. A subset of degradable materials also show potential in high-value fields such as medical implants and tissue engineering scaffolds. Through composite functional design, controlled drug release, factor delivery, and enhanced cell adhesion can be achieved, expanding their applications in high-end medical devices. Their prevalence in high-value, niche applications (e.g., implants and advanced wound care) is largely driven by their superior biocompatibility and controllable degradation; yet, their high unit production cost remains a limiting factor for widespread adoption in commodity disposable medical products where cost-efficiency is paramount. Furthermore, for applications requiring extended shelf life, the insufficient performance stability of some bio-based materials under typical storage conditions poses a challenge.

## Industry and Agriculture

In industrial and agricultural sectors, renewable resource-based degradable fibers provide new solutions for environmentally friendly production. Degradable geotextiles are widely used in water conservancy projects, highway construction, and slope protection. After serving their stabilization and protection roles, they gradually degrade, eliminating the need for subsequent demolition and disposal. Agricultural mulch films, made from materials such as PLA and starch-based polymers, maintain soil moisture and temperature, inhibit weed growth, and naturally degrade after crop harvest, reducing white pollution.

In industrial filtration, filters made from PLA or modified cellulose offer high filtration precision and chemical resistance, suitable for liquid filtration, air purification, and industrial waste gas treatment. Compared with traditional synthetic fiber filters, degradable filters can be harmlessly disposed of at the end of their service

life, reducing waste treatment costs and environmental burdens. These applications not only promote the construction of green industrial chains but also provide important support for the development of fiber materials under the circular economy model. However, wide-scale adoption in these sectors is significantly hampered by cost constraints, as the price point of these bio-based materials is often substantially higher than traditional synthetic alternatives. For demanding applications like geotextiles, insufficient long-term mechanical stability and poor controllability of the degradation rate under diverse environmental field conditions remain critical technical barriers that need to be overcome to ensure reliability.

## **CURRENT CHALLENGES AND FUTURE TRENDS**

### **Current Challenges**

Despite their significant advantages in environmental protection and sustainable development, renewable resource-based degradable textile materials face multiple challenges in large-scale application and industrialization. Raw material preparation and processing costs are generally higher than those of traditional petroleum-based fibers, limiting their competitiveness in the mid-to-low-end market. Performance stability is insufficient—for example, strength degradation and dimensional changes may occur under humid and hot conditions, affecting wearing comfort and durability.

Poor controllability of degradation rate is another key technical bottleneck: excessively fast degradation shortens product service life, while excessively slow degradation undermines environmental benefits. In terms of processing adaptability, some degradable materials exhibit poor compatibility with existing equipment in spinning, weaving, and dyeing processes, requiring additional modifications or new process development. Raw material supply depends heavily on agricultural and forestry resources, which are sensitive to climate change, land-use constraints, and fluctuations in crop yield. This may lead to competition with food security, triggering discussions on resource allocation and ethical issues.

### **Future Trends**

Future development of renewable resource-based degradable textile materials should advance in parallel with green manufacturing, functional expansion, and full-life-cycle management.

In green synthesis and processing, efforts should focus on reducing the use of organic solvents and harmful chemicals, adopting low-energy-consumption, high-efficiency, and recyclable production processes to lower environmental burdens and costs.

In functionalization and smart design, molecular structure engineering and multi-scale compounding can enable novel functions such as environmental responsiveness, controlled release of active substances, and regulated degradation.

In compounding and diversification, combining organic polymers with inorganic nano-materials and bioactive substances can significantly enhance mechanical strength, weather resistance, and special functions (e.g., antibacterial activity, flame retardancy, and conductivity).

Simultaneously, a full-life-cycle management system should be established, forming a closed-loop cycle from raw material cultivation, production and processing, product use, to recycling and reuse, promoting the transformation of the textile industry chain toward green and low-carbon development. The realization of these trends depends on interdisciplinary collaboration, policy support, and sustained market demand for green products.

## CONCLUSIONS

Renewable resource-based degradable textile materials play a crucial role in addressing environmental pollution and promoting resource recycling. In recent years, driven by advances in materials science, green chemistry, and bioengineering, their performance has continuously improved and application fields have expanded. However, large-scale industrialization requires breakthroughs in cost reduction, performance stability enhancement, and controlled degradation. In the future, interdisciplinary collaborative innovation and policy guidance are expected to drive these materials to occupy an important position in the global textile industry, providing strong support for the achievement of sustainable development goals.

### *Author Contributions*

Conceptualization –Yongtao Jiang and Dinglei Feng; methodology – Yongtao Jiang and Dinglei Feng; investigation – Yongtao Jiang and Dinglei Feng; writing-original draft preparation – Yongtao Jiang and Dinglei Feng. All authors have read and agreed to the published version of the manuscript.

### *Conflicts of Interest*

The authors declare no conflict of interest.

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## **REFERENCES**

- [1] Ma YB, Xiao ZQ. Application and challenges of degradable synthetic materials in the textile industry. *Journal of Textile Engineering*. 2025; 3(03):60-69.
- [2] Kong MX, Cheng ST, Li H. Application of degradable synthetic fibers in the textile field. *China Fiber Inspection*. 2025; (06):22-26.
- [3] Wang YM, Zhang H. Current status of degradable textiles and their degradation performance test standards. *China Fiber Inspection*. 2025; (06):30-33.
- [4] Zheng YY. Role and innovative research of medical textile materials in chronic wound care. *Chemical Fiber & Textile Technology*. 2025; 54(05):10-12.
- [5] Liu M. Categories and development prospects of biodegradable fabrics. *West Leather*. 2025; 47(09):54-56.
- [6] Shi LY. Development of environmentally friendly textile materials and research on green economic effects. *Textile Reports*. 2025; 44(03):27-29.
- [7] Xu ZH. Technology of degradable fiber materials and development of environmentally friendly new fabrics. *Textile Reports*. 2024; 43(04):12-14.
- [8] Liu T, Cheng K, Niu FF, Xiao LW, Chen GB, Zhu JH, et al. Synthesis, structure-property relationships of biodegradable polyestaramides and their applications as textile materials in medical and health fields. *Technical Textiles*. 2024; 42(03):1-11.
- [9] Sun SJ, Yu JC, Zhou WL, Peng MC, Li G. Research progress on degradable fiber materials and their applications. *Technical Textiles*. 2023; 41(10):9-17.
- [10] Hu XM, Wang LS. Application of new materials in textile fabrics under carbon peaking and carbon neutrality goals. *Tianjin Textile Science & Technology*. 2023; (04):46-49.
- [11] Yin HF, Zhu HW, Qiao GH. Application progress of biodegradable nonwoven materials for filtration and packaging. *Cotton Textile Technology*. 2022; 50(S1):32-37.

- [12] Sun Y, Liu Y, Kang WH. Process performance optimization of new degradable agricultural nonwoven mulch films. *China Fiber Inspection*. 2022; (07):108-111.
- [13] Hong Y, Bao HY, Wu B. Current status and development trends of biodegradable materials in the apparel industry. *Journal of Fashion Technology*. 2022; 7(02):95-100.
- [14] Ming JF. Research status and countermeasures of microplastic pollution in the textile field. *Cotton Textile Technology*. 2022; 50(06):80-84.
- [15] Liu SH, Xu J, Zhang W, Huang YB, Gong JX. Research progress on antibacterial properties of biodegradable textile materials. *Shanghai Textile Science & Technology*. 2021; 49(12):4-9+16.
- [16] Skobova N, Gorohova A, Yasinskaya N, Papko A. Energy-saving technology for dyeing textile materials from protein fibers with natural dyes using natural mordants. *Vestnik of Vitebsk State Technological University*. 2024; 48(2).
- [17] Tharanga M, Gunasekera U. Characterization of new cellulosic fiber derived from *Lasia spinosa* (L.) thwaites rhizome and its potential use as biodegradable textile material. *Heliyon*. 2024; 10(10). doi: 10.1016/j.heliyon.2024.e31117
- [18] Sunidhi M. Biodegradable textile polymers: a review of current scenario and future opportunities. *Environmental Technology Reviews*. 2023; 12(1):441-457. doi: 10.1080/21622515.2023.2227391
- [19] Repon MR, Islam T, Islam T, Ghorab AE, Rahman MM. Cleaner pathway for developing bioactive textile materials using natural dyes: a review. *Environmental Science And Pollution Research International*. 2023; 30(17):48793-48823. doi: 10.1007/s11356-023-26131-0
- [20] Lobregas MOS, Buniao EVD, Leño Jr JL. Alkali-enzymatic treatment of *Bambusa blumeana* textile fibers for natural fiber-based textile material production. *Industrial Crops & Products*. 2023.
- [21] Noureddine B, Ramzi K, Aminoddin H. Ecofriendly Dyeing of Textile Materials with Natural Colorants from Date Palm Fiber Fibrillium. *Sustainability*. 2023; 15(2). doi: 10.3390/su15021688
- [22] Todorka SMJ. Sustainable Panels with Recycled Textile Materials for Improving Classroom Acoustics. *INTER - NOISE and NOISE - CON Congress and Conference Proceedings*. 2019; 259(3):6523-6530.