

Application of Biomass Adhesives in Interior Home Furnishing Engineering

GuangYuan Bai^{1,*}, Cunlei Bian^{1,3}, Liusu Wang²

¹Blueprint Design Project Company Limited of Jinan, Jinan, Shandong, China

²School of Art and Design, Qilu University of Technology, Jinan, Shandong, China

³School of Mechanical Engineering, Shandong University, Jinan, Shandong, China

Abstract: In recent years, as environmental concerns have surged, biomass adhesives have increasingly captured the spotlight as a promising substitute for traditional petrochemical-based adhesives. These adhesives, sourced from naturally renewable materials, not only emit minimal levels of volatile organic compounds (VOCs) but also possess the remarkable quality of being biodegradable. This paper focuses on exploring the typical applications of biomass adhesives in areas such as flooring installation, wall decoration, furniture manufacturing, and soft furnishing materials. It summarizes existing challenges, including performance deficiencies, relatively high costs, and limited market recognition, while proposing strategies to address these issues through technological advancements, policy support, and market promotion. By leveraging molecular design, optimizing production processes, and developing multifunctional features, the performance of biomass adhesives can be significantly enhanced. Furthermore, policy incentives and consumer education can buttress broaden their market adoption, positioning biomass adhesives as a pivotal component in green home decoration and sustainable development.

Keywords: Biomass Adhesives; Interior Home Decoration; Eco-Friendly Materials; Sustainable Development

1. Introduction

As the global emphasis on sustainable development deepens, the demand for eco-friendly materials in the construction and decoration industry continues to grow. Traditional petrochemical-based adhesives, characterized by high VOC emissions and non-renewable resource origins, have

increasingly faced restrictions from both market forces and regulatory policies. In contrast, biomass adhesives, derived from naturally renewable feedstocks, offer significant advantages such as environmental sustainability, low toxicity, and biodegradability. These attributes have made them a focal point in both research and practical applications in the adhesive field. In interior home decoration projects, adhesives not only play a critical role in ensuring construction quality but also directly influence indoor air quality and occupant health. Therefore, investigating and promoting the use of biomass adhesives in flooring, wall treatments, furniture, and soft furnishing materials aligns with the industry's green development goals while simultaneously addressing issues of resource conservation and environmental pollution. By integrating the development of biomass adhesives into the broader context of sustainable innovation, they stand to provide viable solutions for achieving eco-friendly interior design and long-term environmental benefits.

2. Environmental Friendliness of Biomass Adhesives

2.1 Analysis of Environmental Protection and Sustainability

Compared to conventional petroleum-based adhesives, biomass adhesives stand out due to their natural origin, renewability, and biodegradability, offering pronounced environmentally friendly attributes. Traditional adhesive production heavily depends on non-renewable petrochemical resources, often accompanied by high energy consumption and significant greenhouse gas emissions. In contrast, biomass adhesives, primarily derived from natural macromolecules such as starch, lignin, and cellulose, possess the potential to

reduce carbon emissions and mitigate environmental pollution^[1]. For instance, Professor Guo Jianwei's research team developed biomass adhesives using cottonseed meal and sawdust, achieving not only compliance with environmental standards but also delivering cost advantages and high bonding strength. By rationally utilizing biomass resources, these adhesives present a sustainable development pathway for the interior decoration industry.

2.2 Control and Evaluation of Volatile Organic Compounds (VOCs) Emissions

Volatile organic compounds (VOCs) are regarded as major contributors to indoor air pollution, posing risks to both human health and the environment. Traditional adhesives are often associated with significant VOC emissions, a problem exacerbated in confined indoor spaces. In contrast, biomass adhesives, with their natural composition, dramatically curtail VOC emissions. The research team led by Lü Ang at Wuhan University developed cellulose-based adhesives utilizing aqueous bonding technologies, achieving excellent environmental performance without chemical modifications, thereby completely eliminating VOC emissions. Similarly, international chemical company BASF has been promoting waterborne adhesive materials with low VOC content, characterized by low odor and environmentally friendly properties. These advancements further highlight the competitive edge of biomass adhesives, positioning them as an ideal choice for eco-friendly home decoration materials^[2].

2.3 Health Impacts and Compliance with Green Material Standards

The safety of interior decoration materials is directly linked to the health of occupants. Biomass adhesives, owing to their natural raw materials, contain little to no harmful chemicals, effectively minimizing health risks. Formaldehyde-based adhesives, commonly used in traditional home decoration, are a notorious source of indoor air pollution, with formaldehyde emissions potentially leading to long-term health issues. Biomass adhesives, however, can completely replace formaldehyde-containing products without compromising bonding performance. Under the stringent requirements of GB 33372-2020

Limits of Volatile Organic Compounds in Adhesives, standards for VOC limits in indoor adhesives have become increasingly rigorous, driving the adoption and proliferation of low-VOC biomass adhesives^[3]. Against this backdrop, the research and promotion of biomass adhesives not only enhance indoor air quality but also propel the evolution of green material standards, providing safer and more environmentally friendly solutions for the home decoration industry.

3. Typical Applications of Biomass Adhesives in Interior Home Decoration Projects

3.1 Application in Flooring Installation

The choice of adhesive during flooring installation significantly impacts the durability and environmental performance of the flooring itself. Traditional solvent-based adhesives often emit harmful substances, compromising indoor air quality; by contrast, biomass adhesives, with their low VOC emissions and excellent bonding properties, present an ideal alternative for flooring applications. For instance, Covestro has developed polyurethane adhesives characterized by high strength and durability, suitable for engineered wood and wood assembly, making them highly applicable to flooring installation^[4]. The use of biomass adhesives in flooring highlights several advantages:

- ①Environmental Friendliness: Derived from natural materials, they reduce reliance on petrochemical resources and minimize the carbon footprint.
- ②Safety: Low VOC emissions mitigate health risks to both construction workers and occupants.
- ③Superior Performance: With excellent bonding strength and durability, they meet the rigorous demands of flooring installation.

3.2 Application in Wall Decoration

Wall decoration materials greatly influence both indoor aesthetics and air quality. Biomass adhesives, employed for bonding wallpapers, panels, and other decorative materials, offer an eco-friendly and efficient solution. Nippon's high-performance white adhesive paste, a biomass adhesive with high viscosity, strong adhesion, and excellent moisture resistance, is

suitable for bonding plywood, fiberboard, wood, and paper. Its production process avoids harmful substances such as formaldehyde and benzene, ensuring a non-irritating and hypoallergenic material that is both environmentally friendly and health-conscious. The advantages of biomass adhesives in wall decoration include:

- ①Versatility: Adaptable to various substrates, including wood, fiberboard, and paper.
- ②Moisture Resistance: Effectively prevents dampness on walls, extending the lifespan of decorative materials.
- ③Ease of Application: Facilitates easy application and cleanup, improving construction efficiency.

3.3 Application in Furniture Manufacturing

Adhesives play a pivotal role in furniture manufacturing, and biomass adhesives, owing to their eco-friendly properties and superior performance, are increasingly replacing traditional formaldehyde-based adhesives^[5]. For instance, Jowat SE, a German adhesives manufacturer, produces industrial adhesives extensively used in the furniture industry, offering high-quality edge-banding hot melts, wrapping hot melts, and assembly adhesives to cater to diverse furniture manufacturing needs. Key advantages of biomass adhesives in furniture production include:

- ①Health and Sustainability: Free from harmful substances such as formaldehyde, aligning with modern environmental standards for furniture.
- ②Efficient Production: Rapid curing enhances production efficiency, meeting the demands of large-scale manufacturing.
- ③Superior Performance: Ensures strong adhesion, structural stability, and durability of furniture.

3.4 Application in Soft Furnishing Materials

Soft furnishing materials, such as curtains, carpets, and sofas, play a crucial role in interior design. Biomass adhesives can be utilized in their manufacturing and installation, offering safe and environmentally friendly solutions. For instance, 3M's water-based adhesive 1000NF is suitable for bonding foam, lightweight materials, various wood panels, canvas, and plywood in applications such as furniture and mattresses. This adhesive, free

from VOCs, complies with environmental standards. The application of biomass adhesives in soft furnishings offers the following advantages:

- ①Flexibility: Adapts to the unique properties of soft materials, ensuring long-lasting bonding performance.
- ②Safety: Non-toxic and harmless, safeguarding indoor air quality and overall health.
- ③Wide Applicability: Suitable for the production and installation of a variety of soft furnishing materials, meeting diverse design needs.

4. Challenges and Prospects in the Application of Biomass Adhesives

4.1 Challenges in Current Applications

Despite their pronounced environmental benefits and broad application potential, biomass adhesives face several challenges in practical use. Firstly, their performance has yet to fully match that of traditional petrochemical-based adhesives, particularly in critical parameters such as bonding strength, water resistance, and durability. Under conditions of high humidity or temperature, certain biomass adhesives may exhibit performance degradation due to material characteristics, limiting their applicability in outdoor or high-demand environments. This performance gap restricts their penetration into high-end markets. Additionally, the production costs of biomass adhesives remain relatively high, as the raw materials—primarily derived from natural biomass resources such as starch, cellulose, and lignin—often involve expensive acquisition and preprocessing stages. The production process of biomass adhesives is also comparatively complex and has not yet achieved full industrialization or scalability. Consequently, their unit production costs are higher than those of traditional adhesives, thereby constraining market competitiveness. Furthermore, storage and transportation stability pose another issue: due to their natural origins and chemical properties, biomass adhesives generally have shorter shelf lives and are prone to decomposition or performance degradation under unsuitable conditions, such as improper temperature or humidity during storage and transport. This

instability not only complicates supply chain management but also inconveniences end-users. Finally, consumer awareness and acceptance of biomass adhesives remain limited. Many consumers are accustomed to traditional products and lack sufficient understanding of the environmental and performance advantages of biomass adhesives, which hinders broader market adoption.

4.2 Directions and Potential for Technological Improvements

Addressing the performance and cost challenges of biomass adhesives hinges on technological innovation and improvement. Molecular design and chemical modification represent key avenues for enhancing their performance. For instance, chemically modifying natural polymers like protein and lignin through functional group modification can strengthen intermolecular forces, thereby improving bonding strength and durability. Blending modified lignin with polyvinyl alcohol (PVA), for example, can yield high-strength biomass adhesives capable of meeting outdoor construction requirements. Optimization of production processes is equally critical for cost reduction. Current production methods for biomass adhesives typically involve resource-intensive steps such as raw material extraction, modification, and synthesis. Introducing green technologies—such as enzyme-catalyzed reactions or microwave-assisted extraction—can significantly lower energy consumption and curtail the use of chemical reagents, thereby cutting costs. These green processes also minimize byproducts and enhance resource utilization, promoting sustainability across the industry. Developing multifunctional biomass adhesives is another promising direction. By integrating nanotechnology, adhesives can be endowed with additional properties such as water resistance, fire retardancy, and antibacterial effects. Such advancements not only broaden application scenarios but also enhance product value. Multifunctional biomass adhesives hold particular promise in sectors such as healthcare, bio-packaging, and smart home systems. Moreover, intelligent material design offers a novel pathway for biomass adhesive development. Leveraging artificial intelligence (AI) and machine learning technologies can

enable the simulation and optimization of molecular structures, accelerating the research and development process. This data-driven approach allows for the rapid creation of high-performance adhesives tailored to market demands.

4.3 Necessity of Policy Support and Market Promotion

Policy support plays a pivotal role in the widespread adoption and application of biomass adhesives. Governments can enact stringent environmental regulations to limit the use of traditional high-VOC adhesives, thereby highlighting the environmental advantages of biomass alternatives. Many countries and regions have already implemented mandatory standards for formaldehyde and VOC content in building materials, creating favorable conditions for the promotion of biomass adhesives. Financial subsidies and tax incentives could further support research and production efforts, reducing corporate R&D costs and attracting greater investment to accelerate the development of the biomass adhesive industry. Additionally, government-sponsored research projects and collaborations between universities, research institutions, and enterprises can facilitate the rapid commercialization of technological advancements. In terms of market promotion, raising public awareness and acceptance of biomass adhesives is crucial. Companies and industry associations can organize awareness campaigns, publish product white papers, and conduct educational initiatives to inform consumers about the environmental and health benefits of biomass adhesives. Media platforms and social networks can also serve as powerful tools to enhance consumer environmental consciousness. Establishing standardized benchmarks for biomass adhesives is essential for regulating market practices and building consumer trust. Industry associations should work toward unified standards encompassing performance evaluation, environmental requirements, and quality testing. This would not only alleviate consumer concerns but also promote fair competition among enterprises. Furthermore, international cooperation represents a significant avenue for advancing the development of biomass adhesives. In light of the growing global emphasis on sustainability,

countries and regions can collaborate on technical exchanges and trade partnerships to jointly drive technological progress and application. Within the framework of the United Nations' Sustainable Development Goals (SDGs), both developing and developed nations can share technological achievements, fostering mutual benefits.

5. Conclusion

Biomass adhesives, with their distinct environmental advantages, exhibit significant potential for application in interior home decoration projects. Through an in-depth exploration of their typical applications, it has been observed that they strike an initial balance between performance and eco-friendliness in areas such as flooring installation, wall decoration, furniture manufacturing, and soft furnishing materials. However, challenges remain in terms of bonding performance, production costs, and market acceptance. Technological innovation is key to addressing these issues, enabling improved bonding strength, durability, and multifunctionality, while optimized production processes can effectively reduce costs. Policy support, industry standardization, and market promotion are equally critical drivers for their widespread adoption. As environmental regulations become increasingly stringent and consumer awareness of green materials continues to grow, the scope of biomass adhesives in the building and decoration sector is expected to expand significantly, contributing to the industry's sustainable development. Future advancements in technology and market integration are poised to inject new vitality into the global green

home decoration industry.

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