

Analysis of the Application of New Eco-friendly Materials in Interior Design

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Abstract:

With the deepening advancement of the global “dual carbon” strategy and the significant rise in consumer health awareness, the interior design industry continues to adapt to societal development. Traditional interior materials not only hinder ecological conservation but also fail to meet people’s growing personal needs. In contrast, the eco-friendly attributes of new environmentally friendly materials directly determine the ecological value, health standards, and sustainability of interior spaces. Consequently, the research, development, and application of eco-friendly materials have become paramount. Against this backdrop, new eco-friendly materials are gradually replacing traditional ones as the mainstream choice in interior design, thanks to their outstanding advantages in environmental protection, sustainability, and high performance. In summary, as a new type of material, eco-friendly materials are increasingly being applied across various fields, contributing more to the sustainable development of society.

Keywords:

Interior Design, New Eco-Friendly Materials, Health, Ecology

1. Overview of New Eco-Friendly Materials

New eco-friendly materials refer to a category of materials characterized by low resource consumption, minimal environmental pollution, high resource utilization, and safety for human health throughout their entire life-cycle from raw material sourcing and production processing to usage and waste disposal. Compared to traditional decorative materials, they offer multiple advantages including ecological sustainability, health and safety, practicality, and economic viability. These benefits are the core reasons for their widespread adoption in interior design. Currently, new eco-friendly materials represent a key development direction in modern architectural design, centered on reducing building energy consumption while alleviating environmental burdens.

1.1. Core Advantages of New Eco-Friendly Materials

Ecological and Environmental Advantages: These materials reduce environmental impact throughout their life-cycle, primarily manifested in two aspects. Firstly,

resource utilization focuses on renewable resources—such as repurposing industrial waste that might otherwise be discarded as raw materials. Second, pollution control: Clean production techniques replace traditional high-pollution processes during manufacturing. This ensures effective emission control throughout the entire life-cycle from production to use—significantly reducing environmental pollution. For example, using bamboo (matured in 3-5 years) instead of traditional solid wood reduces dependence on forest resources due to its rapid regeneration. Additionally, bamboo processing waste can be pulverized and recycled as composite board material, achieving a “production-to-regeneration” circular economy [1].

Health and Safety Advantages: As a vital living space, the materials used in indoor environments directly impact human health and safety. The safety attributes of eco-friendly materials mitigate health hazards from indoor environments. Furthermore, certain new eco-friendly materials possess active purification and health protection functions, meeting the demand for “smart health solutions”. Therefore, new eco-friendly materials should be utilized to create non-toxic, harmless indoor environments, avoiding harm from substances like formaldehyde, benzene, and radon in materials, and reducing the incidence of diseases caused by indoor air pollution, such as respiratory illnesses, allergic reactions, and leukemia [4]. For example, eco-friendly coatings containing nano-titanium dioxide can decompose harmful substances in the air under light exposure, achieving purification efficiencies exceeding 80%. The material revolution manifests in the complete abandonment of cement, replacing it with 3D-printed composite materials made from local soil, slaked lime, and natural fibers. This material not only possesses structural strength and thermal inertia but also reduces production carbon emissions by 50% [2].

Functional and Practical Advantages: Compared to traditional materials, new eco-friendly materials excel in multiple aspects. **Functional diversity:** These materials offer multiple composite functions such as thermal insulation, fire resistance, and waterproofing. Their lightweight and thin profile allows them to serve as insulation layers while enhancing building energy efficiency. **Design adaptability:** The variety in form, color, and texture makes them suitable for diverse interior styles. For instance, recycled wood veneers can be processed to mimic the grain patterns of various precious woods, satisfying the pursuit of natural interior aesthetics while protecting the environment.

1.2. Classification of New Eco-Friendly Materials

New eco-friendly materials exhibit significant diversity in types and properties, leading to multiple classification approaches. The academic community commonly employs a dual-dimensional classification based on “raw material source + core function.” Integrating existing research and industrial practice, these materials are categorized into five major types: renewable natural eco-friendly materials, industrial recycled eco-friendly materials, bio-based eco-friendly materials, functional eco-friendly materials, and smart eco-friendly materials. Renewable natural eco-materials originate from renewable natural resources in the environment. Through simple processing, they are transformed into materials with eco-friendly attributes. Their core characteristics include natural origin, renewability, and biodegradability. Common renewable natural resources include bamboo, wood, and natural stone. Utilizing these materials reduces damage to the natural environment. Industrial recycled eco-friendly materials involve reusing waste. They are produced from industrial byproducts—such as slag, waste liquids, exhaust gases, and discarded industrial products—through

processes like recycling, processing, and modification. Bio-based eco-friendly materials utilize biotechnology, employing animal and plant bodies, microorganisms, and their metabolic products as raw materials. Key examples include bio-based plastics, bio-based fiber materials, and bio-based adhesive materials. Functional eco-materials build upon basic environmental attributes by employing technological means to impart specific functions to decorative materials. This dual-functionality enhances both environmental sustainability and practicality, creating safer and more comfortable indoor spaces. Smart eco-materials integrate environmental properties with intelligent technologies, representing innovative material design approaches.

2. The Bidirectional Relationship Between New Eco-Materials and Interior Space Design

2.1. New Eco-Friendly Materials Optimize Interior Spaces

The relationship between new eco-friendly materials and interior space design is not unidirectional. Instead, it is a mutually reinforcing dynamic where material innovation opens new avenues for design, while design demands drive material advancement. Continuous technological breakthroughs in new eco-friendly materials enable interior design theory and practice to adapt to innovation, creating a virtuous cycle of mutual achievement and collective progress. Moreover, functional breakthroughs in these materials enhance the practical value of interior spaces, meeting diverse needs across various scenarios. In traditional interior design, functions like thermal insulation, soundproofing, fire resistance, and moisture control were often constrained by material limitations. However, the adoption of new eco-friendly materials effectively resolves these challenges, enabling comprehensive upgrades and optimizations across all functional aspects of interior spaces.

For thermal insulation and energy efficiency, new eco-friendly insulation materials maintain stable indoor temperatures. Vacuum insulated panels, for instance, offer significantly better insulation than traditional materials, reducing the need to constantly adjust air conditioning and saving electricity costs. Regarding soundproofing, modern cities are filled with traffic noise and neighborhood activity, impacting living and working comfort. New eco-friendly sound-absorbing materials effectively block noise interference, minimizing disturbances. In terms of color expression, the hues of new eco-friendly materials are predominantly soft and fade-resistant, creating visually soothing spaces that easily foster a warm atmosphere. These colors often derive from the materials' inherent natural properties, offering excellent durability and stability to maintain the space's aesthetic appeal over time—such as bamboo's light brown tones or the natural veining of recycled stone. Regarding texture, these materials offer rich, refined textures that convey distinct atmospheres based on their inherent characteristics, delivering varied sensory experiences. For instance, the natural wood grain of recycled wood veneers lends warmth and approachability, bridging the psychological distance between occupants and the space. Conversely, the cool, hard texture of recycled metal surfaces readily creates sleek, avant-garde modern spaces.

2.2. Interior Space Design Drives Innovation in New Materials

Contemporary interior design increasingly prioritizes functionality, with distinct spaces demanding varied material properties. These diverse application scenarios drive continuous upgrades in eco-friendly materials to meet multifaceted needs.

Hospitals prioritize antimicrobial properties and ease of cleaning; hotels require materials that combine aesthetics with high performance; residential environments emphasize health and comfort. These distinct demands drive eco-friendly materials toward greater specialization and enhanced functionality. Most new building and decorative materials are green and eco-conscious, preserving living environments while offering features like odor elimination, antimicrobial properties, temperature regulation, and humidity control. Compared to traditional materials, they deliver superior safety and environmental performance.

In hospital renovations, traditional materials fail to meet professional requirements for antibacterial/antiviral properties, repeated scrubbing, and resistance to disinfectant corrosion, making them unsuitable for medical hygiene standards. Researchers have therefore developed specialized eco-friendly hospital materials that inhibit bacterial growth while withstanding repeated use of common disinfectants like alcohol and chlorine-based solutions. Crucially, these materials release no harmful substances, ensuring safety and environmental sustainability. Material selection must also adapt to diverse indoor environments. Spaces characterized by darkness, dampness, poor ventilation, mold susceptibility, and stagnant air require finishes with anti-mold, moisture-resistant, and air-purifying properties. Existing mold-resistant regenerated fiber acoustic panels, for instance, simultaneously absorb noise, inhibit fungal growth, and decompose airborne pollutants-effectively improving environments detrimental to human health. This targeted development addresses practical challenges in renovation while expanding the application of eco-friendly materials. Beyond functionality and environmental adaptability, materials must also convey “emotional warmth” and humanistic care. This is particularly crucial in specialized settings like senior apartments and nursing homes, where materials must not only be slip-resistant, impact-proof, and ensure elderly safety but also feel warm and considerate. Consequently, products like slip-resistant eco-friendly flooring and impact-resistant recycled plastic wall panels have been developed—combining safety with a sense of humanistic care.

3. Specific Application Cases of New Eco-Friendly Materials in Interior Spaces

3.1. Polylactic Acid (PLA) Bio-Based Composite Panels: Biodegradable Eco-Friendly Panels

As a quintessential biodegradable material, polylactic acid (PLA) utilizes renewable biomass like corn and cassava as raw materials. It offers excellent performance while significantly reducing plastic waste pollution [6]. PLA bio-based composite panels gained widespread adoption in interior decoration after 2022, emerging as a representative new eco-friendly material. They undergo complete natural degradation without releasing harmful substances like formaldehyde or benzene, addressing environmental pollution issues associated with traditional panels and marking a significant innovation in interior decorative materials. PLA boasts excellent performance with a lifespan exceeding 15 years. Its production process generates minimal volatile organic compound (VOC) emissions, making it safe for human health. It is easy to process-standard operations like sawing, planing, nailing, and veneering suffice-and can meet diverse needs for cabinetry, wall panels, or decorative surfaces. PLA also offers aesthetic appeal. Natural plant dyes can be added to create various colors, and its surface can mimic wood or stone textures, making it adaptable

to minimalist, natural, or light luxury design styles. Take the 2024 Shanghai Pudong New Area eco-friendly family apartment project as an example. The core requirements for this project were zero formaldehyde, low pollution, and a long-term service life exceeding 15 years. Consequently, the design team selected PLA bio-based composite panels for all cabinetry, wall paneling, and children's room decorative panels. Post-installation, indoor formaldehyde levels measured just 0.01mg/m³, significantly below national standards. One year into use, the panels maintain stable performance. This case study fully validates the adaptability and practicality of PLA bio-based composite panels in home renovation scenarios, particularly for environments demanding high environmental and health standards. It provides a practical reference for the engineering application of new eco-friendly decorative materials.

3.2. Nano Titanium Dioxide Modified Water-Based Coatings: Functional Coatings Capable of Air Purification

Nano titanium dioxide modified water-based coatings were successfully developed and deployed in 2021. Based on water-based acrylic resin, it efficiently decomposes airborne pollutants under visible light. Experimental testing by scholars shows its formaldehyde decomposition efficiency exceeds 85%, benzene exceeds 80%, and total volatile organic compounds (TVOC) reach over 75%, with purification effects lasting over 10 years. Taking the 2024 wall renovation project at the Fenglin Road Campus outpatient building of Fudan University Children's Hospital as an example, the design team applied nano-titanium dioxide modified water-based paint to core areas like public corridors and pediatric wards. This decision prioritized the vulnerable immune systems of children and the stringent health and safety requirements for their healthcare environment. Additionally, considering children's heightened sensitivity to color, the paint was formulated with a water-based acrylic resin base combined with natural mineral pigments to create soft hues like light blue, pale green, and warm yellow. This approach aligns with children's visual perception characteristics while delivering outstanding environmental performance and purification efficacy, fully meeting the project's core requirements and validating the paint's adaptability and practicality.

3.3. Recycled Glass Aggregate Translucent Concrete: An Eco-Friendly, Light-Transmitting Building Material

The recycled glass aggregate translucent concrete primarily uses discarded architectural glass as its raw material, blended with cement, mineral admixtures, and optical fibers. Discarded architectural glass accounts for over 60% of the composition. This innovation transforms waste into valuable resources while imparting translucency to concrete, shattering the conventional perception of concrete as heavy and monotonous. Its ecological value is significant: each cubic meter of concrete produced consumes 0.8 tons of waste glass, substantially reducing waste pollution. Its light transmission can be self-regulated. By adjusting the density of optical fibers, transparency can be flexibly controlled between 10% and 40%. Light passing through creates uniform, soft light spots, serving both as natural illumination and decorative elements. Performance-wise, it excels with compressive strength exceeding 30MPa, fully meeting standards for non-load-bearing interior components. Its high surface hardness and superior wear resistance surpass those of ordinary decorative concrete. Additionally, it achieves Class A fire resistance, withstands acid and alkali exposure,

and resists freeze-thaw cycles, making it suitable for humid environments and areas with significant temperature fluctuations. Its surface can be polished and colored to accommodate diverse design styles. Take the interior renovation project of the “Light and Shadow Ecology Pavilion” at the 2025 Nanjing Old Machine Tool Factory Cultural and Creative Park as an example. Centered on the design concept of “Green Regeneration·Light and Shadow Art” this project selected recycled glass aggregate translucent concrete as the core material for exhibition hall partition walls and light-transmitting decorative panels. The unique light and shadow effects created by this concrete became a highlight of the venue, fostering a comfortable viewing atmosphere while embodying green environmental principles. This case fully demonstrates the core advantages of recycled glass aggregate translucent concrete, which combines ecological value, practical performance, and aesthetic appeal.

3.4. Mycelium Composite Decorative Materials: Biosynthetic Materials of the Future

Mycelium materials are organic, compostable, and biodegradable natural fungal substances. They typically utilize agricultural waste like corn stalks or sugarcane bagasse as structural substrates, combined with cultivated edible fungi whose mycelium binds and solidifies the mixture [3]. They can fully decompose waste within 3 to 6 months, with the degraded products serving as organic fertilizer for fields. Performance-wise, they exhibit high compressive strength and toughness, featuring a cork-like surface texture with a warm, smooth tactile feel. Take the 2024 Hangzhou “Nature Symbiosis” ecological art exhibition as an example: the design team used mycelium materials to decorate the entire exhibition hall. Combined with the material's inherent light brown natural grain, it evoked a sense of “coming from nature and returning to nature.” Simultaneously, the exhibition fixtures and seating within the hall were all molded as a single piece from mycelium, eliminating the need for additional connectors while being both sturdy and aligned with environmental principles.

4. Conclusions

From enhancing building energy efficiency and reducing operational costs to creating healthy, safe indoor environments and significantly lowering environmental footprints, eco-friendly materials demonstrate immense potential [1]. Materials like PLA-based bio-substrates and nano-titanium dioxide-modified coatings not only alleviate indoor environmental burdens but also open new design possibilities, enabling spaces that are both visually appealing and tactilely rich. However, current research and application remain insufficient. Some material properties are still underdeveloped, and costs remain relatively high. Practical implementation often faces challenges such as mismatches between design and materials, or construction techniques that fail to meet practical requirements. Related theoretical knowledge is lacking, and interdisciplinary research is not sufficiently in-depth. Nevertheless, the future direction is clear: first, endowing materials with more composite functions to achieve multi-functional capabilities; second, enabling more precise adaptation to different usage scenarios through customized solutions; third, advancing design and material R&D in tandem to ensure mutual coordination. In summary, novel eco-friendly materials will play a pivotal role in future development. As research deepens, the variety of environmentally sustainable materials will expand, and their application prospects will grow increasingly broad.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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