Craft and Aesthetic Characteristics of Resin-inlaid Wood and Its Application in Household Products

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Resin-inlaid wood is a material integration approach in which liquid resin is poured into cracks or structural cavities of wood and cured to form a composite structure. In recent years, this technique has attracted increasing attention in furniture and interior design due to the distinctive visual and tactile effects created by the contrast between resin and wood, inspiring numerous handcrafted and design-oriented works. However, systematic studies on resin-inlaid wood remain limited. This study reviews the material selection and processing procedures involved in resin-inlaid wood craftsmanship and analyzes its aesthetic characteristics from the perspectives of visual presentation, tactile contrast, structural expression, and emotional values. Representative household products are further examined through case analyses. In addition, a questionnaire survey based on the product semantics approach was conducted to explore participants' preferences toward resin-inlaid wood products, providing references for the design application and future development of resin-inlaid wood in household products.

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Keywords: Resin-inlaid wood; Aesthetic characteristics; Casting process; Household wood products

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INTRODUCTION

Driven by the concepts of green and low-carbon development and sustainability, renewable natural materials have received increasing attention in the fields of materials science and product design (Sierra-Pérez *et al*. 2016; Yin *et al.* 2026; Feng *et al.* 2026; Su *et al.* 2026). Wood, as a typical biomass renewable resource, features low carbon emissions, recyclability, and favorable mechanical properties. Its natural texture, color variation, and diverse anatomical structures also provide distinctive visual expression, leading to its wide application in architecture, furniture, and craft products (Akpan *et al*. 2021).

However, during growth and processing, wood is prone to defects, such as cracks, knots, and voids, which may affect both material utilization and visual quality. In recent years, design practice has increasingly reinterpreted such "material defects" as potential aesthetic resources, transforming them into meaningful visual elements through design interventions.

In this context, resin materials have been introduced into woodcraft practices. Resins have long been used in cultural heritage conservation for crack filling and structural reinforcement. Because of their excellent fluidity, color adjustability, and transparency, resins not only can stabilize wooden structures during crack filling, but they also can create

distinctive visual contrasts between transparent and solid materials (Tang *et al*. 2025). Through resin-inlaid wood craftsmanship, cracks in wood can be transformed into dynamic and layered visual structures, resulting in wooden artifacts that combine material contrast with artistic expression.

With the growing interest in functional composite materials, studies on wood–resin composites have steadily increased (Fig. 1), covering topics such as material modification (Lin *et al*. 2021), structural reinforcement (Wang *et al*. 2021), transparent wood preparation (Zhang *et al*. 2023), and craft design (Seki *et al*. 2024). Nevertheless, systematic research on resin-inlaid wood craft products remains relatively limited. Therefore, this study takes resin-inlaid wood products as the research object. It systematically reviews the selection of resin materials and corresponding processing techniques, analyzes their stylistic characteristics and aesthetic expressions, and categorizes existing products. Furthermore, by applying product semantics analysis and questionnaire surveys, this study explores the relationship between material attributes and participants' aesthetic preferences, aiming to provide insights for future design and application of resin-inlaid wood craft products.

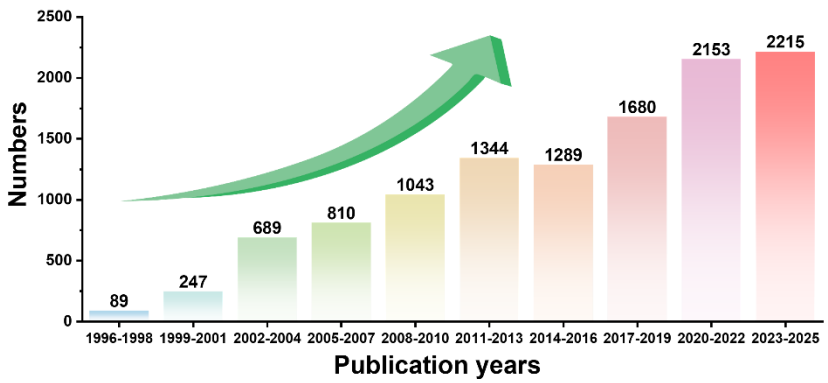

Fig. 1. Publications on resin–wood composite materials since 1996 based on a Web of Science search using the keywords "resin" and "wood"

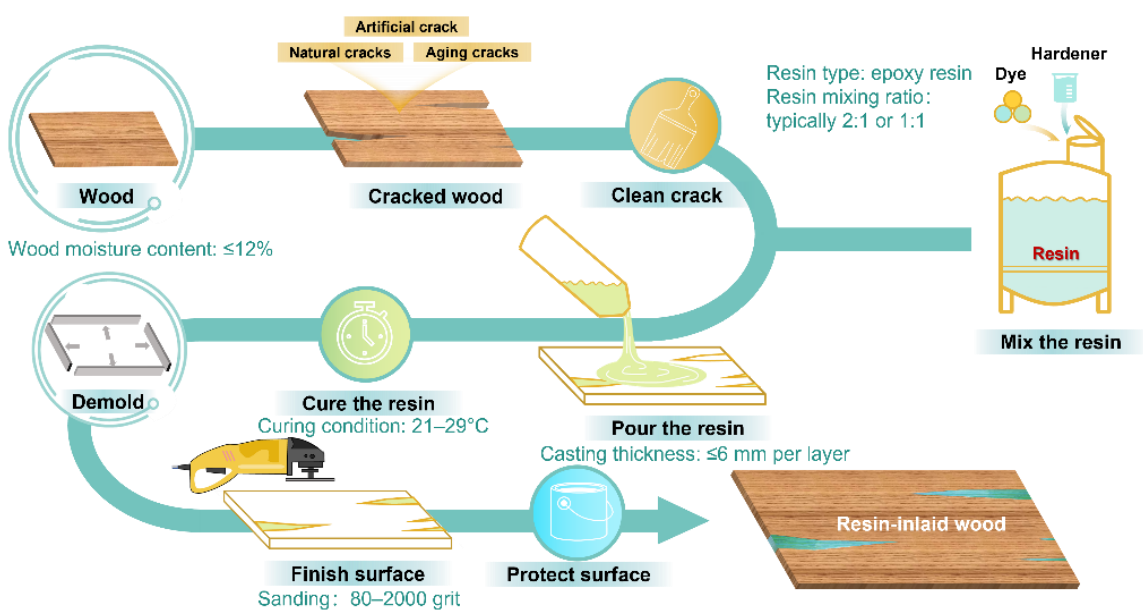

Fig. 2. Process flow diagram of resin-inlaid wood

RESIN-INLAID WOOD CRAFT

Resin-inlaid wood craftsmanship is a processing method in which liquid resin is poured into cracks or pre-designed structural spaces within wood and subsequently cured to form a composite structure (Fig. 2).

Resin Selection

Epoxy resin, polyester resin, polyurethane resin, and UV resin are common resins used in woodcraft applications. These materials differ in viscosity, curing time, shrinkage rate, and weather resistance; therefore, resin selection should consider factors such as product size, crack morphology, and service environment. Polyester resin cures rapidly and is inexpensive but shows higher curing shrinkage, which may generate internal stresses at the wood–resin interface (Haider *et al.* 2007). Polyurethane resin provides flexibility but has limited transparency and yellowing resistance, while UV resin is mainly suitable for thin-layer treatments or localized repair. Among these materials, epoxy resin is most widely used in resin-inlaid wood due to its low curing shrinkage, high transparency, and good color adjustability (Ashrafi *et al.* 2019; Kwon *et al.* 2021). During curing, interfacial interactions between epoxy resin and wood may involve possible chemical interactions between epoxy groups and hydroxyl groups in wood, although the extent of such reactions depends on the resin formulation, curing conditions, and surface characteristics. Meanwhile, the porous structure of wood promotes resin penetration and mechanical interlocking, enhancing interfacial bonding (Wang *et al.* 2021). Epoxy resins are generally classified into art, coating, and casting types, among which low-viscosity casting epoxy resins are particularly suitable for resin-inlaid wood processes.

Wood Pretreatment and Crack Construction

Wood with clear grain patterns and stable properties should be selected, and its moisture content should be controlled below 12% to prevent deformation caused by moisture variation or internal stress. Prior to casting, the wood surface should be leveled, cleaned, sanded (80 to 120 grit), and thoroughly dust-free.

Cracks should be carefully cleaned to remove wood chips, dust, and loose fibers to ensure full contact between resin and the crack walls. Cracks generally originate from three sources: natural cracks, artificial cracks, and naturally aged cracks (Tao *et al*. 2025). Natural cracks are typically formed by drying shrinkage or the release of growth stress, while artificial cracks can be created by cutting or grooving to obtain regular shapes. In some studies, microwave expansion has also been used to induce controllable cracking (Chai *et al*. 2020; Zhang *et al*. 2021). Naturally aged cracks are usually observed in weathered wood. For through-cracks or full casting structures, temporary molds should be installed at the bottom or sides of the wood to prevent resin leakage.

Resin Preparation and Casting

The resin and curing agent should be mixed according to the specified ratio and stirred thoroughly. During the preparation stage, appropriate dyes may be added according to design requirements to adjust transparency, color gradation, and visual effects. To minimize bubble formation, the mixture may be allowed to stand for a short period or subjected to degassing. During casting, the resin should be slowly poured along the crack opening. For products with larger dimensions or deeper cracks, a layered casting method

is typically adopted. The thickness of each layer should not exceed approximately 1/4 inch (about 6.35 mm). The next layer is poured only after the previous layer has partially cured, which helps reduce internal stress caused by concentrated exothermic heat. After pouring, a propane torch can be lightly passed over the surface to eliminate bubbles.

Resin Curing and Demolding

After casting, the resin should be cured at room temperature (approximately 21 to 29 °C) in a clean and dust-free environment. Once the resin is fully cured, demolding can be performed, followed by inspection of the filling integrity. If local defects are observed, additional filling or surface sanding may be required. In some cases, further resting may be necessary to allow the release of residual internal stresses.

Surface Finishing of Wooden Products

After curing, height differences or overflow residues often remain on the product surface, making subsequent sanding necessary. The sanding process should gradually proceed from coarse sandpaper (80 grit) to fine sandpaper (up to 2000 grit) to achieve a smooth transition between the resin and wood surfaces. Polishing can then be applied to enhance the transparency and gloss of the resin. Finally, wood wax oil or clear varnish may be applied to improve moisture resistance and wear resistance, while simultaneously enhancing the visual contrast between the wood grain and the resin-filled areas.

STYLISTIC CHARACTERISTICS AND AESTHETIC EXPRESSION

The aesthetic characteristics of resin-inlaid wood products arise from the integration of natural and artificial materials (Fig. 3).

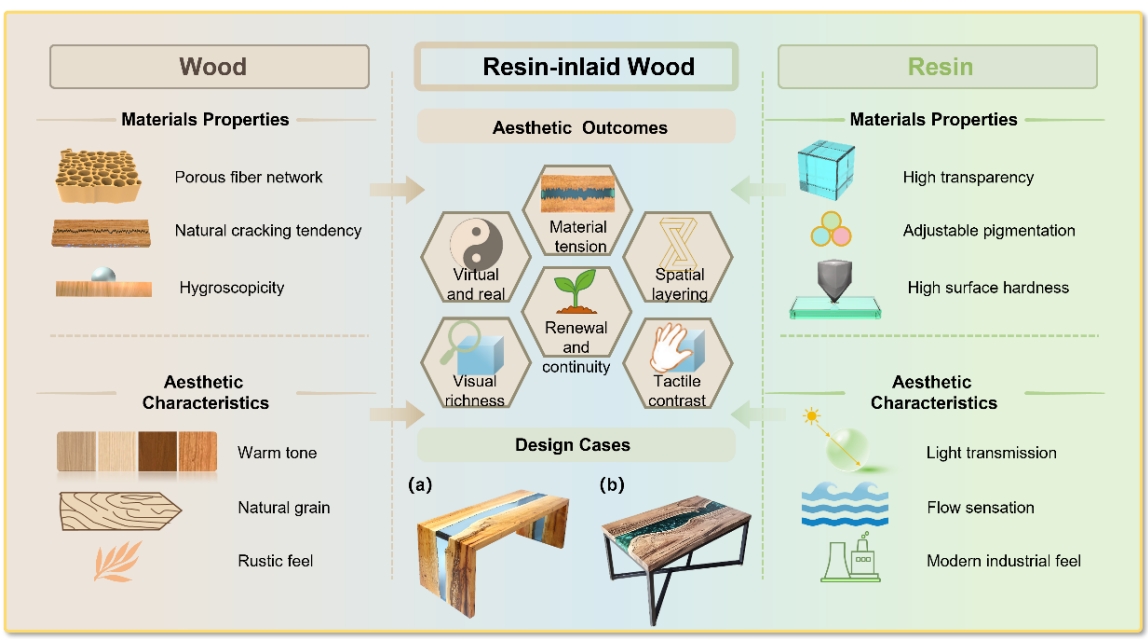

Fig. 3. Material properties of resin and wood and aesthetic characteristics of resin-inlaid wood products. (picture source: (a) https://www.pinterest.com/pin/1130685050252470170/ and (b) https://www.instagram.com/p/DUIdZ5skdM0/?img_index=8

Visual Presentation

The most direct visual contrast arises from the different optical properties of resin and wood. Transparent or semi-transparent resin forms a smooth interface within cracks, while wood retains natural features such as growth rings and fiber textures. Light passing through the resin creates a sense of depth, whereas wood presents a stable and warm appearance. The contrast between the solidity of wood and the transparency of resin reflects the aesthetic concept of the interplay between void and substance in Eastern philosophy. Pigments can also be added to resin to create color contrasts with the natural tone of wood, enhancing visual layering and artistic expression.

Tactile Contrast

Resin and wood exhibit clear differences in tactile perception. Polished resin surfaces are dense, smooth, and slightly cool, whereas wood feels warm or slightly rough due to its fibrous structure. This contrast between cool and warm as well as smooth and rough enriches the sensory experience. Surface treatments can further adjust this relationship: polished resin combined with finely sanded wood creates a refined modern character, while matte resin with preserved saw marks emphasizes a natural and handcrafted aesthetic.

Structural Expression

From a structural perspective, the key characteristic of resin-inlaid wood lies in the reconstruction of wood cracks. Defects or discontinuities in the wood are stabilized through resin filling and visually emphasized as part of the design. The flowing edges formed by resin contrast with the relatively stable geometry of the wood, allowing the structure to maintain order while introducing a sense of movement.

Emotional Value

The integration of resin and wood reflects the combination of modern processing technologies with natural materials, aligning with contemporary design trends that emphasize natural aesthetics and sustainability. Through filling wood cracks, structural defects are transformed into visual features, symbolizing ideas of repair and regeneration. Therefore, resin-inlaid wood products function not only as material composites but also as design expressions that convey technological culture and contemporary aesthetic values.

APPLICATIONS IN THE HOME FURNISHING FIELD

Analysis of Existing Design Cases

In the home furnishing field, resin-inlaid wood has become a representative application *via* integrating material aesthetics, tactile experience, and emotional expression. The natural texture and warm touch of wood create emotional affinity, while transparent and moldable resin expands the expressive possibilities of wooden structures, forming a design language that combines natural characteristics with modern craftsmanship.

Compared with other decorative techniques such as metal inlay and acrylic inserts, resin-inlaid wood exhibits relatively lower performance in terms of mechanical durability and optical transparency. However, it offers greater diversity in material texture expression and form generation. The combination of natural wood grain and castable resin enables

more flexible shaping possibilities, allowing a richer range of aesthetic expressions in home furnishing design.

Product semantics focuses on the symbolic meanings conveyed through product form, material, and structure. In resin-inlaid wood products, resin transparency, color treatment, and the structural relationship between resin and wood cracks influence users' visual perception and emotional associations. Based on this perspective, representative resin-inlaid wood furniture products were analyzed to extract their key material and structural characteristics and corresponding semantic expressions (Table 1).

Table 1. Applications of Resin-inlaid Wood in the Home Furnishing Field

Categories	Images	Product Semantics	Picture Source
Tables		Spatial fluidity; The imagery of a "river"; Dynamic and static combination	https://www.pinterest.com/pin/1130685050252477325/
Storage Furniture		Authentic presentation of materials; Visible expression of structural reinforcement	https://www.pinterest.com/pin/1130685050252475361/
Lighting Products		Light penetration; Balance of warmth and coolness; Depth of light and shadow	https://www.pinterest.com/pin/10485011674030761/
Seating Furniture		Stability and lightness; Contrast between virtual and real; Restoration and continuity	https://www.pinterest.com/pin/331577591330425740/
Doors		Poetic ambiance; Light penetration; Integration of artificial and nature; Aesthetics of craftsmanship	https://www.pinterest.com/pin/1130685050252473868/

Future Design Directions Based on Product Semantics

A questionnaire survey based on the semantic differential method was conducted with 94 participants (38.1% male and 61.9% female), including 27.4% engaged in design-related professions, to compare participants' current perceptions and expected preferences of resin-inlaid wood home furnishing products across three dimensions: material and stylistic attributes, emotional expression, and spatial–functional characteristics (Fig. 4).

The results indicate that existing resin-inlaid wood household products tend to emphasize strong material contrast and formal tension, whereas respondents generally prefer designs characterized by naturalness, softness, and lightness. In the material and style dimension, the expected scores for naturalness and warmth are higher than the current evaluations, while the expected values for lightness and delicacy reach 4.64 and 5.18, indicating a preference for lightweight and refined design expressions. Therefore, future designs should strengthen the natural attributes of materials and optimize structural proportions for everyday use. Meanwhile, respondents show increasing attention to practicality and functional integration. The expected score for practicality reaches 5.19, which is 1.28 higher than the current evaluation, while functionality increases to 4.62. In addition, 71.4% of participants emphasize practical functionality, 63.1% highlight sustainability, and 51.2% support lightweight design. These findings suggest that future resin-inlaid wood furniture design should highlight material texture while strengthening functional performance and ecological awareness, achieving a balance between technological aesthetics and natural qualities.

It should be noted that, although resin-inlaid wood offers significant aesthetic and design value, it still presents several limitations, including long-term durability concerns, UV aging, resin yellowing, and thermal expansion mismatch between wood and resin. These limitations mainly arise from the intrinsic differences in physical and chemical properties between the hydrophilic, anisotropic wood substrate and the relatively brittle, thermosetting epoxy resin system. These issues warrant further attention in future optimization and application studies.

Also, future research may explore more systematic and data-driven optimization of the resin-inlaid wood manufacturing process, drawing inspiration from advanced intelligent scheduling and process optimization methods (Wu *et al*. 2026).

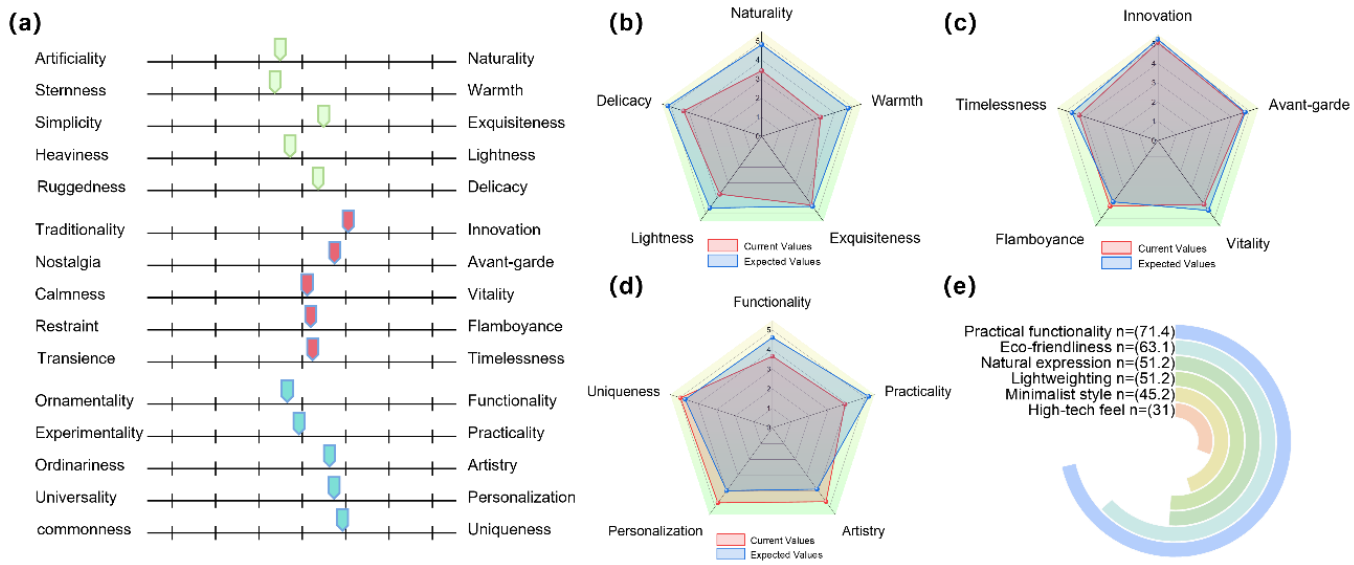

Fig. 4. Research on future design directions based on product semantics: (a) Semantic differential scale used in the survey; (b) Current and expected semantic values of the material and style dimension; (c) the emotional dimension; (d) and the spatial and expression dimension; (e) Expectations for future product design

CONCLUSIONS

1. The resin-inlaid wood technique transforms structural defects in wood into visual features through resin filling and curing, contributing to improved structural integrity and aesthetic expression. This approach reflects the concept of material re-design and aligns with sustainable design principles.
2. A typical process—including wood pretreatment, resin preparation, layered casting, controlled curing, and surface finishing—is essential for ensuring the structural stability and visual quality of resin-inlaid wood products.
3. Differences between resin and wood in optical properties, tactile perception, and structural form create contrasts, such as void *versus* solid, cool *versus* warm, and dynamic *versus* static, which enhance visual depth while conveying symbolic meanings of repair and regeneration.
4. Semantic differential analysis and user surveys reveal that current products emphasize material contrast, whereas users prefer designs that are natural, lightweight, and functionally integrated. Future designs should balance material expression with usability and spatial adaptability, enabling resin-inlaid wood products to integrate into everyday living environments while maintaining contemporary craftsmanship.

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