Handicraft Process, Aesthetic Characteristics, and Design Applications of Molten Metal Inlaid in Wood for Home Furnishings

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The inlaying of molten metal into artificial or natural wood cracks represents an innovative combination of metal and wood. After cooling and solidifying, a unique texture is formed, offering a rich aesthetic experience rooted in its intricate decorative texture. This study systematically summarizes the process steps of molten metal inlaid in wood, including material selection, pretreatment, casting, cooling, and sanding. It elaborates on the aesthetic characteristics and decorative potential of this novel material through three aspects, including visual expression, tactile difference, and cultural value. Selected design cases of molten metal inlaid in wood for home furnishings are analyzed to assess the product design feasibility through the lens of craft aesthetics. The research further provides a guiding direction for its design application in household products.

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Keywords: Molten metal inlaid in wood; *Aesthetic appealing*; *Craftmanship*; *Household wood products*

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INTRODUCTION

The handicraft market has broad prospects, with the global market size exceeding the level of hundreds of billions of US dollars and showing a steady growth trend. Data from GlobeNewsWire suggests that the global handicrafts market reached $906.8 billion in 2024 and is projected to reach $1.94 trillion by 2033, growing at a compound annual growth rate (CAGR) of 83% over the period 2025-2033. The core driving force lies in the rising consumer demand for personalized, culturally rich, and sustainable products (Dash and Mishra 2021). Handicrafts not only serve as a carrier of traditional skills but also have been rejuvenated in the integration of modern design concepts and technologies, becoming an important field connecting art and business (Zheng and Zhu 2021; Hu *et al.* 2024). As shown in Fig. 1, the research field of handicrafts presents interdisciplinary characteristics, involving multiple disciplines such as business economics, arts and humanities, environmental science, engineering, and computer science (Yu *et al.* 2021; Yang *et al.* 2022). Business economics focuses on supply chain optimization and global business model innovation in the handicraft industry, such as the industrialization path of intangible cultural heritage skills. The field of environmental science and engineering is dedicated to developing eco-friendly materials, such as natural dyes and recycled fibers, as well as low-carbon production processes to reduce the ecological footprint (Chen and Sun 2023; Zhang *et al.* 2023a).

Computer science empowers traditional craftsmanship through 3D modeling, AI design tools, and blockchain traceability technology to enhance creative efficiency and product credibility. Art, humanities, and history research focuses on cultural heritage protection and skill inheritance and promotes the systematization of handicraft training courses in combination with educational research (Xie *et al.* 2024; Zhan *et al.* 2024). Therefore, it is necessary to adopt multidisciplinary knowledge to timely sort out and summarize the production techniques of handicrafts.

With the deepening of sustainable design concepts and the breakthroughs in cross-border material integration technologies, molten metal inlaid in wood, as an emerging handicraft, is redefining the functional and aesthetic boundaries of household products. Although traditional wood inlaying techniques, such as mother-of-pearl and metal wire inlay, have artistic value, they generally have limitations such as low efficiency, stereotyped patterns, and weak material interaction (Xiong *et al.* 2022; Zhang *et al.* 2023b). In contrast, the combination of molten metal and wood through dynamic physical-chemical interactions (such as the penetration of molten metal and the inhibition of wood carbonization), not only achieves an integrated innovation of structure and decoration but also gives rise to unique natural textures at the material interface, providing a new possibility for the coexistence of technical controllability and artistic randomness in home furnishings design (Tao *et al.* 2025).

Although there have been design cases of molten metal inlaid in wood products, a complete and systematic analysis of the process and aesthetic characteristics have not yet been reported. Based on this, this paper takes home furnishings as an application scenario, integrates the three perspectives of material science, process engineering, and design aesthetics (Yang and Zhu 2021; Zhu and Niu 2022). This paper also summarizes the process of molten metal inlaid in wood, describes its aesthetic characteristics and decorative value, and reviews the current product application. This study will enrich the research field of new materials for home furnishings and provide theoretical guidance for the design application.

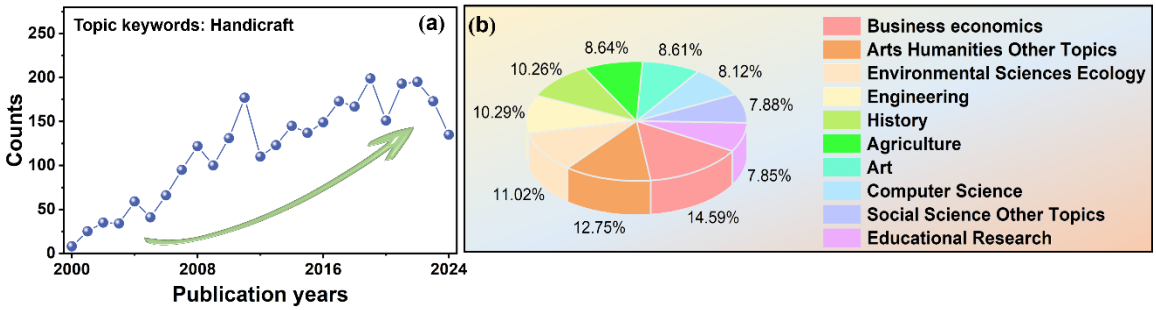

Fig. 1. Research areas on handicrafts: a) publication counts, and b) research area (data source: the number of publications can be found by searching for the keyword “handicrafts” in the Web of Science. picture source: drawn by the author.)

MOLTEN METAL INLAY TECHNIQUE

A molten metal inlay is a type of composite processing that casts liquid metal into the wood cracks and then it cools and solidifies. This approach utilizes the physical differences between metal and wood to create products that are both functional and aesthetically pleasing. Additionally, as the molten metal inlay technique involves the use

of a hot and boiling alloy, it may burn the skin or splash into the eyes. Safety precautions such as wearing lab coats, protective eyewear, and heat-resistant gloves are required throughout. The process steps of the molten metal inlaid in wood are shown in Fig. 2.

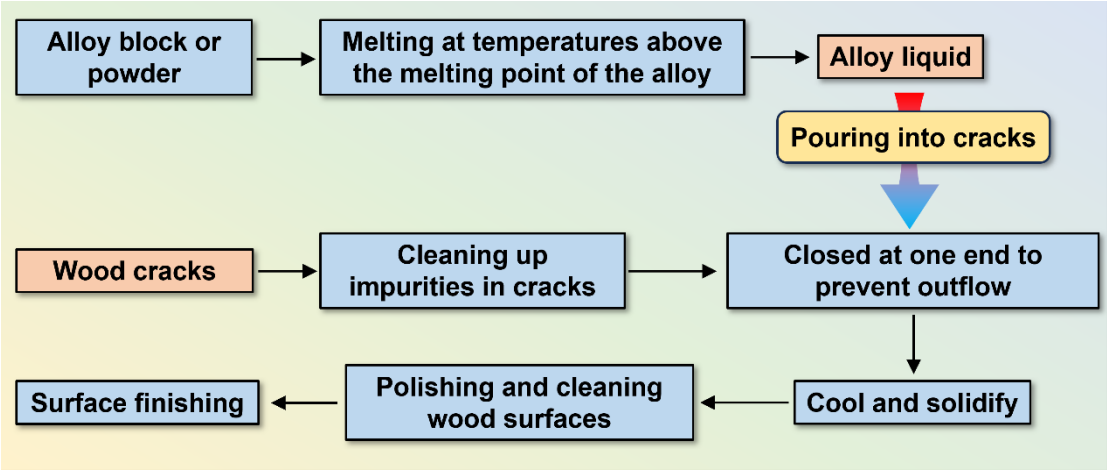

Fig. 2. Process flow diagram of molten metal inlaid in wood

Materials Selection and Pretreatment

On the one hand, alloy blocks or powders are selected as raw material and heated to above their melting point to melt into liquid metal. To avoid damaging the wood properties due to high-temperature carbonization, the melting point of the metal used is generally lower than 250 ℃ (Chai *et al.* 2020). Commonly used metal types are BiPbSnCd, BiPbSn, and BiSn alloys, with processing temperatures ranging from 95 to 170 °C. Powdered metal is more susceptible to heat due to its smaller size and dispersed distribution, and the melted metal has better fluidity, so it is often used for fine filling. On the other hand, wood species with clear grain and stable drying are selected. Commonly used wood species are eucalyptus, radiata pine, poplar, and basswood. To ensure adequate penetration of the molten metal, the cracks need to be thoroughly cleaned to remove impurities such as wood dust or dirt. If necessary, a fire-resistant coating can be applied to the inner walls of the cracks to enhance their high-temperature resistance.

Metal Melting and Casting

The alloy is placed in a container and heated above its melting point, while continuous stirring is required to prevent oxidation or component separation. Temperature control is particularly important, as too high a temperature can easily cause the wood to burn, while too low a temperature leads to insufficient fluidity. Liquid metal is slowly poured along the crack opening to fill the gap by gravity effect and capillary penetration. To prevent the overflow of liquid metal, fire-resistant clay or metal baffles are temporarily used to seal the bottom of the crack. When performing the casting operation, the artisan can slightly shake the wood or use a slender funnel for assistance to ensure that the metal is evenly distributed and that no air bubbles remain. During this process, heat-insulating gloves and goggles should be worn, and the working area should be kept well-ventilated to ensure safety.

Surface Treatment After Cooling

The filled metal will be cooled naturally at room temperature or accelerated with the aid of a fan. After removing the sealing material, the filling integrity needs to be checked. If there are any gaps, a localized remelting repair can be performed. Initial sanding of the metal-wood interface is done using sandpaper or files to remove burrs and spilled residue and to initially flatten the surface. After that, multiple polishing sandpapers from coarse to fine are used to eliminate scratches on the metal surface. The luster of the metal parts can be enhanced with the help of a cloth wheel polisher with polishing paste. Finally, a soft-bristle brush is used to clean the dust in the wood grain gaps and apply wood wax oil. This not only can enhance the moisture resistance, but it also highlights the contrasting beauty between wood and metal.

Product Types Classified According to The Wood Cracks

Wood cracks are mainly categorized into natural and artificial (Fig. 3). Natural cracks include splits formed by drying or decay, as well as holes caused by insect erosion and fungi. Natural cracks are irregular in shape and random in distribution and can be filled with metal to repair the structural strength while retaining the original grain of the wood. They are suitable for making antique-style furniture or restoring historical wood components. Artificial cracks are formed through carving to form customized patterns, or micro-crack networks are generated within the wood using microwave puffing technology (Torgovnikov and Vinden 2010). These cracks are highly designed, combined with the decorative metal inlays, and can be made into modern art ornaments or high-end furniture.

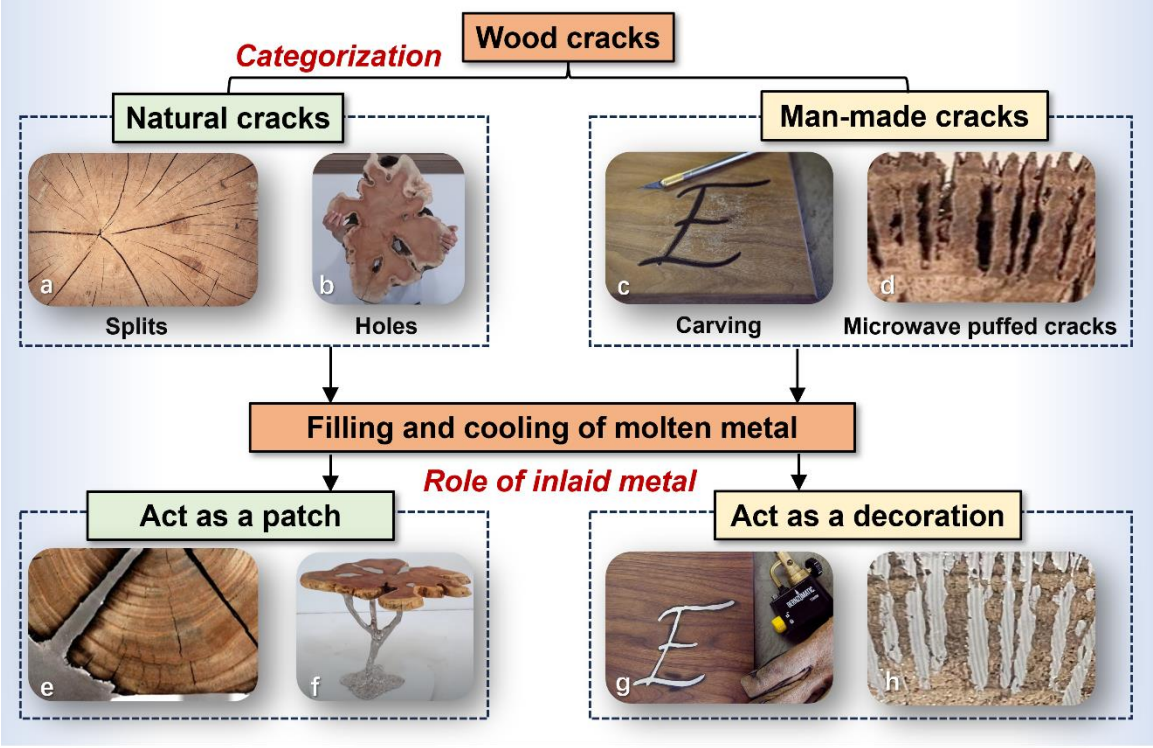

Fig. 3. Classification of wood cracks for use in the molten metal inlay techniques (picture source: (a). https://freerangestock.com/photos/129990/cracked-wood-.html (b, f). https://www.youtube.com/watch?v=SbWJ8ZMOakA; (c, g). https://www.bernzomatic.com/Projects/Make/Metal-Inlay-in-Wood; (d, h). Reference of Tao *et al.* 2023. (e). https://dornob.com/cast-aluminum-and-wood-fuse-into-extraordinary-furniture/)

AESTHETIC CHARACTERISTICS ANALYSIS

The aesthetic characteristics of molten metal inlaid in wood present the contrasting beauty of color, craftsmanship, reality and illusion, nature and industry, and materials, specifically in the three aspects of visual expression, tactile differences, and cultural values.

Aspects of Visual Presentation

The material contrast between metal and wood creates a strong visual tension. The cold metallic luster and the warm matte wood contrast with each other, like a silver-white alloy flowing through the cracks of the dark wood, creating a conflicting aesthetic of nature and industry. The juxtaposition of metal-filled geometrically carved patterns and the random texture of the wood's natural annual rings and insect holes gives the work a dual narrative of abstraction and spontaneity (Zou *et al.* 2024; Liu *et al.* 2025). The controllable and uncontrollable nature of the process further enhances the visual hierarchy. The penetration path of molten metal in the cracks is guided by the wood fibers. After cooling, it presents branch-like fractals or river-like veins, preserving the primitive wildness of the natural material while incorporating the rational order of artificial intervention.

Aspects of Tactile Differences

The tactile senses of cold, hard, and smooth in metal and the warm, soft, and roughness in wood form a sensory complementarity. The cold-dense feeling of metal and the soft-light feeling of wood alternately trigger tactile memory, enhancing the interaction experience between the user and the object (Jin *et al.* 2025). Tactile contrasts are modulated by surface finishing, for example, the combination of mirrored metal and brushed wood grain highlights a modern minimalism style, while the integration of hammered metal and rough wood conveys a rustic and handcrafted warmth.

Aspects of Cultural Values

The crafts of molten metal inlaid in wood have become a carrier of dialogue between tradition and modernity, nature and technology. On the one hand, the concept of metal repairing wood cracks metaphorically represents the philosophy of imperfection beauty in Oriental culture, reinterpreting the aesthetics of substance sadness through modern materials. On the other hand, the artificial cracks and algorithmically designed metal patterns echo the technological rationality of the digital age. For instance, the implantation of customized letters and patterns in traditional woodwork symbolizes the cross-era integration of craftsmanship (Zhu *et al.* 2024). In addition, the material symbols of different cultures are activated, for instance as a minimalist pairing of metal and pinewood in Scandinavian design conveys functionalism, while the rugged inlay of metal and blackwood in African handicrafts continues the primitive tension of tribal totems.

DESIGN APPLICATION IN HOME FURNISHINGS

Current Design Case

Molten metal inlaid in wood endows contemporary furnishing design with brand-new changes and inspirations with its unique aesthetic appeal and quality. Currently, molten metal inlay techniques are used in furniture, interior decoration, and artistic

creations. The main products are desktop panels, bench panels, decorative ornaments, structural brackets, daily utensils, and clock faceplates (Table 1).

Table 1. Current Molten Metal Inlay Techniques in Woodworking

Product Applications	Images	Descriptions	Picture Source
Desktop panel		Molten metal flows like a river through the wood cracks, contrasting with the elegant grain, giving different feelings of passion and calmness.	https://www.pinterest.com/chaoticwayz/molten-metal-inlays/
Bench panel		The bench panel is divided by metal, giving a strong sense of contrast. The metal extends outwards to form the legs and chair back, rich in decorative and functional attributes.	https://www.pinterest.com/chaoticwayz/molten-metal-inlays/
Decorative ornaments		Liquid metal is poured directly onto the wood surface, the snowflake-like metal enlivens the handicraft.	https://www.studiometallurgy.com/products/molten-aluminium-on-wood-03
Structural brackets		The wooden seat is inlaid with metal in the cracks, and the base and legs are made of metal, presenting a sense of paradoxical contrast between warmth and coldness, softness and hardness.	https://www.solidsmack.com/design/wood-meet-molten-metal-im-sure-youll-get-along-just-fine/
Daily utensils		Metal is inlaid around the bowl surface, and the solid and heavy wood grain gives a lively and dynamic feeling.	https://sokolowskistudios.com/shop/metal-inlay-copper/
Clock faceplates		The wood surface is artificially cut into linear cracks, in which the metal is inlaid to give a sense of regularity and order. It also makes the clock faceplate more dynamic.	https://www.anikasdiylife.com/diy-wooden-clock-metal-inlay/

Future Design Orientation

The future design orientation of molten metal inlaid in wood in the home furnishing field will focus on the functional translation and emotional narrative of the conflict aesthetics, breaking the homogenization tendency of the traditional home furnishing design through the tactile-visual dual comparison strategy (Fig. 5). The sharp contrast formed by the industrial coldness of metal and the natural warmth of wood can be transformed into a

spatial narrative tool. For example, the technological attributes of metal symbolize the modern industrial core, while the organic form of wood carries the humanistic temperature. An emotional buffer layer for human-computer interaction is constructed through hybrid symbols.

By taking full advantage of the material and tactile differences between wood and metal, the products are designed to give consumers a new feeling. For example, the plasticity of the molten metal is utilized to shape the bionic curved surface, forming a dynamic balance with the stable texture of the wood. The goal is not only to meet the comfort requirements of ergonomics but also strengthens the user's hierarchical cognition of the product functions through the difference in the material touch sensations. A balance that enhances the aesthetics of the conflict between wood and metal in terms of color, luster, and touch through mix and match methods. Sustainability goals can be achieved through the creative combination of the metal recycling process and fast-growing wood.

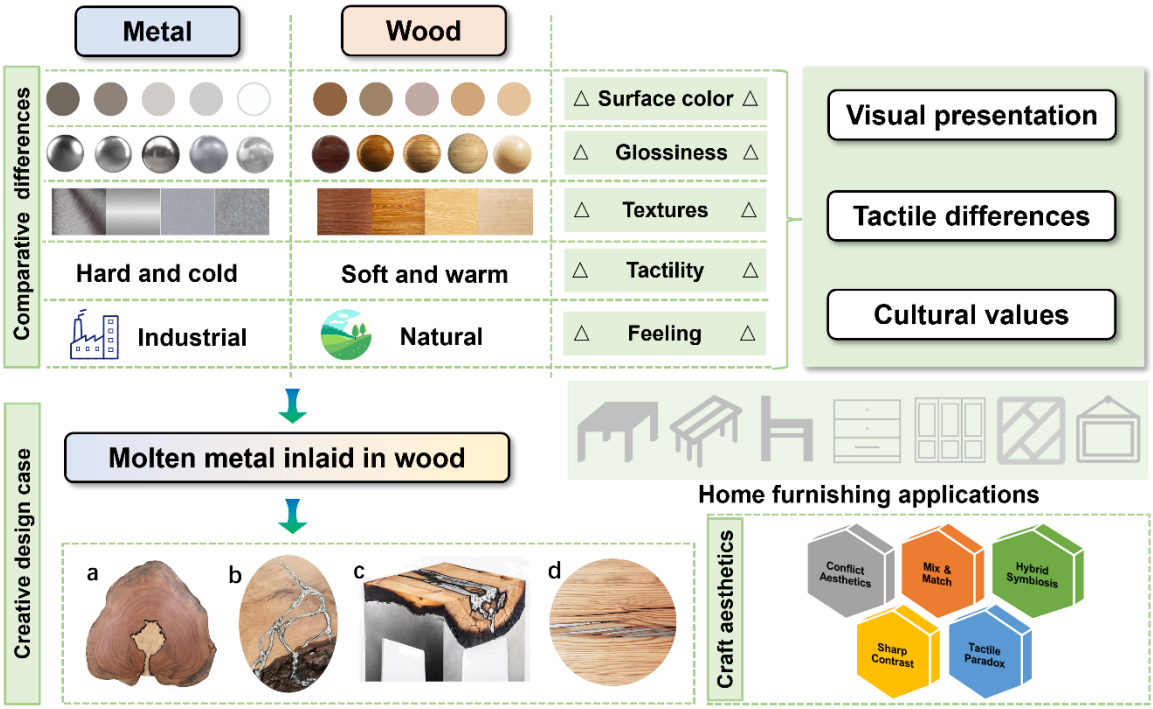

Fig. 4. Craft aesthetics and design orientation of molten metal inlaid in wood.
(Picture source: (a). https://www.metroelement.net/product/petra-acacia-wood-molten-brass-inlay-22h-side-table-natural/
(b). https://www.pinterest.com/chaoticwayz/molten-metal-inlays/
(c). https://www.pinterest.com/pin/hilla-shamia-casts-tree-trunks-in-aluminium-to-create-dramatic-furniture--66639269462820488/
(d). https://www.pinterest.com/pin/vid-name-how-to-molten-metal-inlay--539798705328527893/)

CONCLUSIONS

The process of inlaying wood with molten metal has emerged at a time when material science and art and design are constantly converging. The conclusions of this study are as follows:

1. Molten metal inlaid in wood technology integrates structural reinforcement and decoration through the dynamic interaction between liquid metal and wood cracks. It combines material science, engineering control, and design aesthetics. While traditional crafts are made by gluing metal sheets to wood panels, welding metal parts to wood, *etc*., molten metal is inlaid into the internal cracks of wood, presenting an innovative twist on traditional techniques. Molten metal inlaid in wood technology is both controllable and naturally random. That is, artificial stereotypes of processing or natural cracks become the location of the metal filler, revealing a sense of rationality and randomness.
2. Molten metal inlaid wood mainly involves the steps of material selection, pretreatment, metal melting and casting, cooling and surface treatment. It is characterized by conflict aesthetics, mixing & match, hybrid symbiosis, sharp contrast, and tactile paradox, and currently used in the fields of furniture, interior decoration, and artistic creations.
3. The material contrast and cultural values between metal and wood create a visual and tactile experience of conflict and coexistence, which is expected to be applied to furniture, decorative ornaments, and daily utensils to meet the needs of personalization, functionality, and sustainability. Specifically, blue-grayish metals and yellow-reddish woods give a contrast sense of visual presentation. The hard-cold metal and the soft-warm wood present a tactile contrast. Additionally, wood implies the concept of nature ecology, while metal is a symbol of industrial smelting. Molten metal inlaid in wood shows a culture collision.

In the future, it is necessary to optimize the bonding strength of the wood-metal interface, and enhance its longevity as a high-end artwork. By combining innovative design to lead the in-depth collaboration between technology and craftsmanship, designers can expand new application scenarios.

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