

Scientific Conservation and Restoration of Decorative Calligraphy and Painting Artifacts from the Imperial Interior of the Forbidden City

Xinyi Wang¹

¹ Department of Conservation and Restoration, The Palace Museum, Beijing, China; 13436529096@163.com

* Correspondence: awangyunli@163.com

Abstract

A substantial amount of calligraphy and painting were used for inner space decoration in the Forbidden City, serving as essential artistic elements within court architecture. Unlike traditional forms such as vertical scrolls, hand scrolls, and album pages that are framed for storage, these works were mounted directly onto architectural components and situated within stable microenvironments over long periods. Their mounting materials and methods are different from those of traditional hand scrolls, posing challenges to conventional conservation approaches. In this study, scientific testing and analysis were conducted on the mounting paper used for these paper-based artifacts in the Hall of Mental Cultivation (*Yangxin dian*), were conducted to identify fiber types and compositions. Guided by the principles of material compatibility and reversibility, a targeted restoration method utilizing highly compatible materials was implemented. Based on comprehensive scientific evidence derived from both historical records and material analysis, the precise application of restoration materials provides a replicable scientific framework for conserving similar interior decorative paintings and calligraphy works.

Keywords: calligraphy and painting; scientific conservation; fiber analysis.

1 Introduction

In the various indoor spaces of the Forbidden City, a large number of calligraphy and painting works are affixed to walls, window sashes, partition sashes, inscribed boards, and couplets. These differ from traditional calligraphy and painting works displayed on walls as vertical scrolls (a form of mounting). Scholars refer to these architectural works as "Tieluo" (literally "affixed to walls"). As a unique decorative art form within Chinese architectural spaces, Tieluo occupies an intermediate category between "movable cultural relics" and "immovable cultural relics."

Scholars believe that interior space decorative paintings and calligraphy are the aesthetic mediums of traditional architectural spaces. Their physical existence relies on physical substrates such as walls and partition panels. This intimate relationship dictates their shared material composition. Consequently, research on these interior decorative works is inextricably linked to their architectural environment.

At the same time, the mounting techniques and materials are important elements in defining the paintings and calligraphy within the interior decorative category. For instance, the records

in *The Imperial Workshops Records Archives of the Qing Imperial Household Department* stated: "In the 13th year of the Qianlong reign (1748 AD), in the third month (mounting work), on the fifth day of the first lunar month, eunuch Zhang Liangdong said that the leader Wen Dan handed over a Xuan paper painting by Yu Sheng, a Xuan paper painting by Cao Kui, and a Xuan paper calligraphy by Ji Huang..." The subsequent imperial edict stated: "Yu Sheng's Xuan paper paintings, Cao Kuiyin's paintings, and Ji Huang's calligraphy, they are mounted with one Chinese cun and five fen (approx. 5cm) in blue silk. The rest should be pasted on a single layer of Korean paper. This is approved." The form of the painting core (the painting or calligraphy on paper or silk) after the mounting process remains in an "open" state exposed to the architectural space. This also leads to most of the inner eave decoration paintings and calligraphy in the original space suffering from deterioration, such as stains, hollowing, cracking, and damage.

The Hall of Mental Cultivation (*Yangxin dian*) was built during the Jiajing period of the Ming Dynasty. It is located to the west of the Palace of Heavenly Purity (*Qianqing gong*) and to the south of the West Six Palaces. It was an important place for the emperor to handle state and daily affairs. In 2015, the "Research-based Conservation Project of the Hall of Mental Cultivation (*Yangxin dian*) in the Forbidden City" was initiated. Currently, scientific research on the paper-based cultural relics within the Hall of Mental Cultivation (*Yangxin dian*) has been carried out, primarily focusing on the decorative style and manufacturing techniques of the wall pasting paper. Focusing on the mounting paper used for the inner space decorative calligraphy and painting relics in the Hall of Mental Cultivation (*Yangxin dian*) of the Palace Museum, this study employs scientific detection methods to conduct fiber identification, appropriately selects restoration materials and implements scientific conservation treatments.

2 Hall of Following the Practice (*Tishun tang*)

The Hall of Following the Practice (*Tishun tang*) is the east wing of the rear hall of the Hall of Mental Cultivation (*Yangxin dian*). Originally built during the Ming dynasty, this hall was first named the Hall of Intense Happiness (*Longxi guan*). Although originally built during the Ming Dynasty, its function was defined after the Yongzheng Emperor moved his residence to the Hall of Mental Cultivation. Consequently, it served as the designated living quarters for the Empress during the Qing Dynasty. Notably, Empress Dowager Ci'an resided in this hall during her regency in the early Tongzhi era. The hall's current name and plaque were bestowed by Empress Dowager Cixi.

The interior of the Hall of Following the Practice (*Tishun tang*) is divided into five spaces by partitions, namely, the central bay (*mingjian*), the east secondary bay (*dong cijian*), the west secondary bay (*xi cijian*), the east end bay (*dong shaojian*) and the west end bay (*xi shaojian*). There are four groups of partitions in the hall: the east secondary and east end bays, the east secondary and central bays, and the central and west secondary bays respectively share partitions, while the fourth partition is located independently in the west end bay (Figure 1). These partitions can be covered with paper or sesame gauze. Furthermore, they are adorned with framed silk calligraphy and paintings created by court ministers (Figure 2).

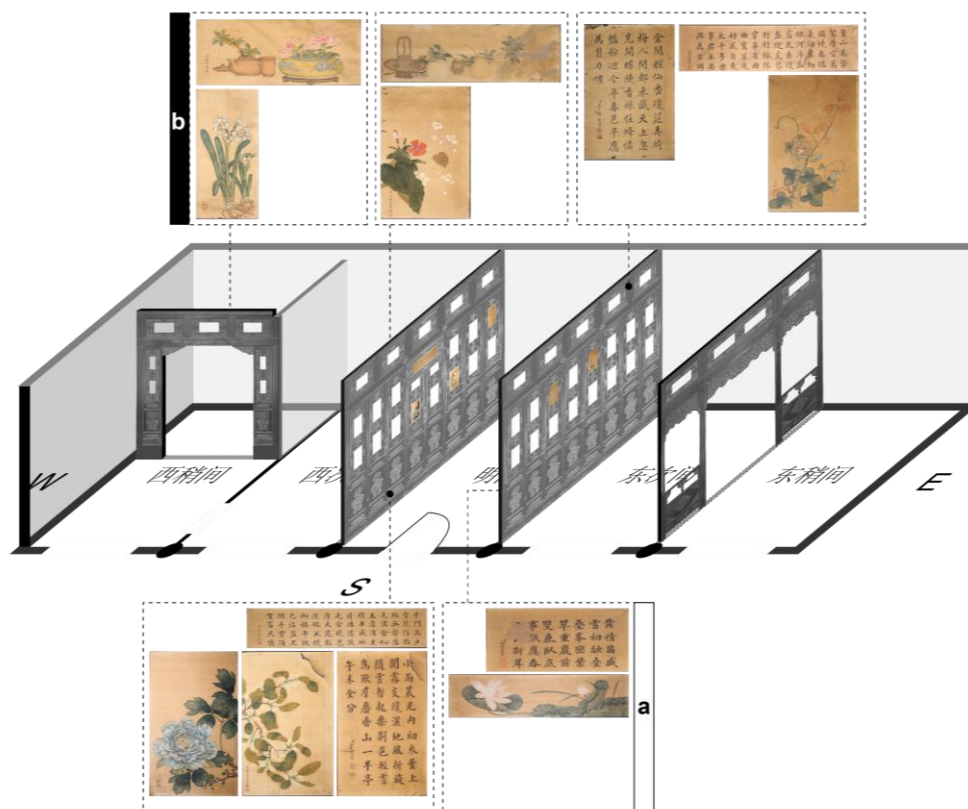


Figure 1. Different calligraphy and painting relics were removed from all partitions in the Hall of Following the Practice (*Tishun tang*).



Figure 2. One of the partitions in the Hall of Following the Practice (*Tishun tang*).

Some inscribed boards and couplets made of paper are hung in this space, such as the "Sui De An Jia" paper plaque inscribed by Empress Dowager Cixi, which has suffered from severe degradation (Figure 3).



Figure 3. "Sui De An Jia" plaque inscribed by Empress Dowager Cixi in the Hall of Following the Practice (*Tishun Tang*).

3 Condition assessment and Deterioration Analysis

A total of 114 calligraphy and painting works were removed from the frame partitions in the Hall of Following the Practice (*Tishun Tang*). The majority exhibited conditions such as soiling, staining, physical damage, and hollowing, alongside missing parts (Figure 4). Hollowing refers to the separation of the backing paper and the lining paper (Figure 5). When the backing paper is damaged, it compromises the structural integrity of the artwork and necessitates its replacement.

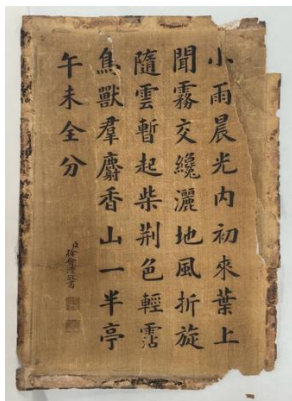


Figure 4. Broken calligraphy with missing parts.

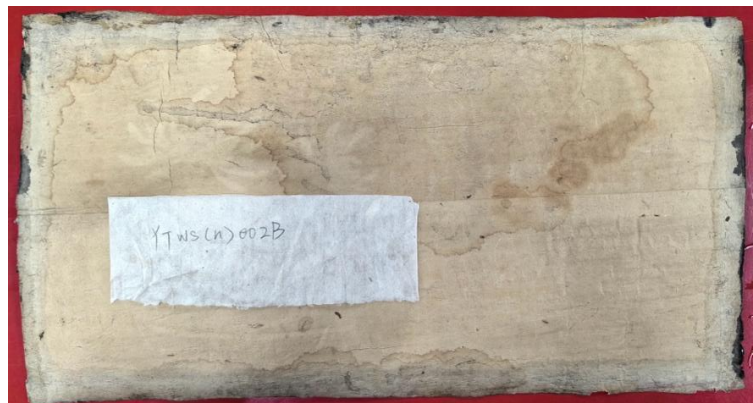


Figure 5. Stained and hollowed-out paper.

Upon visual examination, the front surface of the plaque (Figure 6) was found to be partially damaged, with the backing paper presenting distinct issues of dirt accumulation, degradation, and hollowing (Figure 7).



Figure 6. Front surface of the "Sui De An Jia" paper plaque.



Figure 7. Backing paper of the "Sui De An Jia" plaque.

4 Detection and analysis of mounting paper

Based on the calligraphy and paintings located in the center of the partition, as well as the paper plaque "Sui De An Jia", the author sampled mounting materials from six different historical calligraphy and painting relics. These materials were numbered sequentially to obtain six paper samples for testing (Table 1).

Location	Number	Image
The West frame partition of central bay	YTm(w)016A	

The North frame partition of west end bay	YTws(n)006A	
The South frame partition of west end bay	YTws(n)002B	
	YTws(n)004B	
	YTws(n)007B	
The North wall of central bay	Backing paper of the "Sui De An Jia" plaque	

Table 1. Test Sample Details.

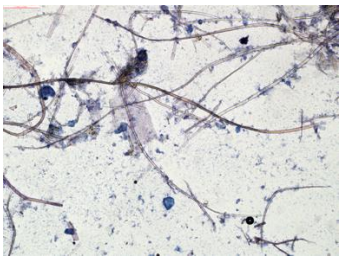
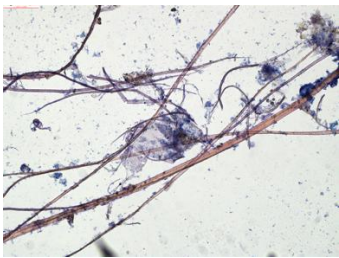
Generally, physical and chemical tests—such as fiber identification, grammage, tensile strength, and breaking length—are performed on paper samples. However, due to the effects of mounting processes (including water immersion and sizing) and natural aging, the data for grammage, tensile strength, and breaking length were inaccurate and failed to reflect the intrinsic properties of the paper. Therefore, this experiment focused primarily on fiber identification.

Appropriate samples were taken from the peelable paper, and the extracted fibers were placed on a glass slide. One to two drops of Herzberg stain were applied for staining and slide preparation. The stained fiber specimens were then examined under an Olympus BX43 microscope equipped with a Beijing Lunhua XWY-VIII fiber measuring instrument at a magnification of 10X. Fiber identification was conducted based on the coloration induced by the Herzberg stain and the morphological characteristics of the fibers. Furthermore, a fiber

analyzer was used to observe the fiber morphology, structure, types, and colors of heterogeneous cells. The detection method was in accordance with the microscopic procedures outlined in the national standard *GB/T 4688-2002: Analysis of Fiber Composition of Paper, Paperboard, and Pulp*. The fiber types were determined by referencing Wang Juhua's *"Papermaking Raw Materials of China an Atlas of Micrographs and the Characteristics of Fibers"*.

The Herzberg stain reacts with lignin present in plant fibers, yielding distinct color reactions depending on the lignin content. Consequently, this method is widely employed to determine the botanical origin of paper fibers. Furthermore, the Herzberg stain can effectively differentiate pulp types; specifically, chemical wood pulps typically develop a blue coloration.

In this analysis, none of the dyed fiber specimens exhibited a blue coloration. Consequently, it was determined that all the selected mounting papers were handmade paper. Comparing the dyed fiber samples with standard reference charts revealed that among the six samples tested, three were composed of mixed pulp (bamboo and bast fibers) and three were bast paper. Specifically, two of these were identified as mulberry bark paper. Detailed identification results for each sample are presented in Table 2.

Number	Fiber Micrograph	Fiber Taxonomy
YTm(w)016A		bamboo and bast fibers
YTws(n)006A		bamboo and bast fibers
YTws(n)002B		bast fiber

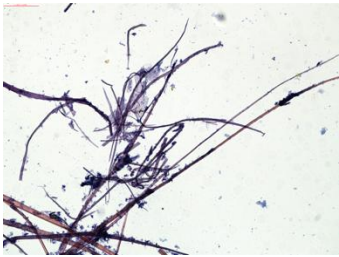
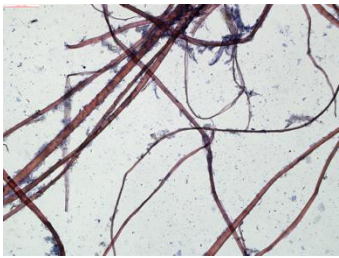
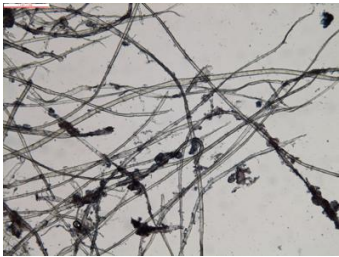
YTws(n)004B		bamboo and bast fibers
YTws(n)007B		bast fiber
Backing paper of the "Sui De An Jia" plaque		bast fiber

Table 2. Identification Results of Fibers in Each Sample.

The Qing imperial court possessed an extensive collection of bast fiber papers, the vast majority of which were Korean papers manufactured from mulberry bark. Korean paper (Hanji) was widely applied in calligraphy and painting artifacts within the Imperial Interior of the Forbidden City. It served a wide variety of functions, most notably as a material for the mounting of calligraphy and paintings.

According to the Qingdang (Official Records) of the Workshop for Various Crafts, the Workshop's Inventory Ledger records that on the 11th day of the 11th month in the 38th year of the Qianlong reign (1773), eunuch Zhang Jinxi conveyed an order from Head Eunuch Dong Wujing, who handed over a Xuan paper painting by Hong Wu (弘晔). The painting was lined with Korean paper and mounted with a one Chinese cun (3.33 cm) wide blue silk border on all four sides.

The dating of the mounting for the tested artifact aligns closely with the historical period of widespread Korean paper usage documented in archival records; therefore, it is highly likely that the mounting paper is indeed of Korean origin.

However, the samples retrieved in this study are severely degraded, and the surviving fibers have not adequately preserved their original characteristics. Relying solely on chemical staining techniques makes it difficult to definitively determine whether the composition is pure mulberry bark. Consequently, further investigation using alternative scientific analytical techniques is warranted in future studies.

5 Conservation Treatment Overview

In the context of this study, the comprehensive technical protocol for the conservation of calligraphy and painting artifacts comprises five sequential stages: baseline information acquisition, diagnostic analysis, conservation planning, treatment implementation, and archival documentation. By synthesizing historical craftsmanship records with accumulated conservation experience, we formulate a rational and artifact-specific treatment methodology. Furthermore, grounded in materials research and analytical characterization of the mounting components, we select appropriate repair materials and tools with precision. Throughout the entire conservation process, the principle of minimal intervention is strictly adhered to. The treatment is executed through a series of procedures, including surface cleaning, washing, backing paper replacement, infill mending, and full-color retouching (Figure 8).



Figure 8. Conservation Treatment.

It is noteworthy that during the washing procedure, water temperature must be strictly controlled to prevent excessive heat. Furthermore, for calligraphy and painting artifacts suffering from severe damage and extensive fragmentation, the original fragments must be strictly prevented from shifting or becoming misaligned during the replacement of the backing paper.

6 Conclusion

This study establishes a critical link between the material characterization of historical artifacts and the evidence-based formulation of conservation strategies. Through rigorous scientific testing and analysis of the mounting papers used in the Hall of Mental Cultivation (*Yangxin dian*), the specific fiber types and material compositions were precisely identified. This in-depth characterization provided the essential empirical basis for the subsequent selection of restoration materials.

Rather than relying on generalized assumptions, the choice of restoration materials was strictly guided by these analytical results to ensure maximum material compatibility and reversibility. This evidence-based approach enabled a targeted restoration method that respected the physical integrity of the original artifacts. By grounding the intervention in comprehensive scientific data and historical records, this study demonstrates that precise material analysis is a prerequisite for effective conservation. Ultimately, this research provides a replicable, scientific framework for the restoration of similar interior decorative paintings and calligraphy, ensuring that future interventions are both chemically stable and historically authentic.

Given the extremely limited sample sources in this study, coupled with the scarcity and severe

aging of the paper samples, the data obtained fail to adequately represent the overall characteristics of interior decoration in the Forbidden City. Because these historical backing papers were removed from calligraphy and painting scrolls, their original properties have been altered by natural aging. Consequently, a comprehensive understanding cannot be achieved solely based on the current samples. Future research should involve testing a wider variety of paper samples to draw broader, more generalized conclusions.

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