

in the sixteenth century with Yi I and his nine bends at Gosan; this trend was then revitalized in the eighteenth century by the literati of the Noron faction. At first, the literati of the Yeongnam region did not follow the Noron faction in seeking to identify nine bends, but by the late eighteenth century, they had changed course, beginning with the nine bends of Muheul, associated with Jeong Gu. Subsequently, the Yeongnam literati began actively seeking to designate nine bends at places associated with previous scholars and sages.

As such, the nine bends at Dosan were designated in the late eighteenth century. In selecting the final locations of the nine bends, the followers of Yi Hwang chose places that had close ties to their leader, including scenic areas or the homes of his friends and esteemed colleagues. By designating the nine bends at Dosan, Yi Hwang's followers associated Yi's actual retirement site of Dosan with the nine bends at Mt. Wuyi, with its much larger symbolic and rhetorical implications. Overall, these efforts were intended to reinforce the lineage of Neo-Confucian scholarship, beginning with Zhu Xi and continuing to Yi Hwang.

Dosando paintings were first produced in the late seventeenth century, about 100 years after Yi Hwang had settled in Dosan. After another 100 years or so, in the late eighteenth century, the nine bends at Dosan were declared. Over time, through the nineteenth century, these two practices became intertwined, as Dosando painters began to depict the nine bends of Dosan in their works. Hence, the area of Dosan became an indelible symbol to commemorate Yi Hwang, helping to firmly establish the tradition of the nine bends culture in the Yeongnam region. ㄸ

TRANSLATED BY PARK MYOUNGSOOK

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#### Selected Bibliography

- Ahn, Hwi-joon (안휘준). 1987. "Korean Landscape Painting of the Early and Middle Choson Period." *Korea Journal* 27: 4-17.
- Jang Jina (장진아). 1998. *Late Joseon True-View Landscape Paintings by Literati* (조선 후기 문인진경산수화 연구). MA thesis, Department of Archaeology and Art History, Seoul National University.
- Jeong, Woolak (정우락). 2009. "Construction of the Muheul

Jeongsa Academy by Jeong Gu and His Writing Activities" (寒岡 鄭述의 武屹精舍 건립과 저술활동). *Journal of Nammyeong Studies* (南冥學研究) 28: 273-314.

- Kang, Sinae (강신애). 2004. *The Nine Bends at Mt. Wuyi Paintings of the Joseon Dynasty* (조선시대 무이구곡도 연구). MA thesis, Korea University.
- Kim, Munkie (김문기). 2008. "The Grove of the Nine Bends at Dosan and Poems on the Nine Bends at Dosan" (陶山九曲園林과 陶山九曲詩). *Yi Hwang Studies and Korean Culture* (퇴계학과 한국문화) 43: 193-233.
- Lee, Jongho (이종호). 2010. "Administration of the Nine Bends by the Literati of the Yeongnam Region and Choe Nambok's Baengnyeong Seosa Academy" (영남선비들의 구곡경영과 최남복의 백련서사). *Yeongnam Studies* (영남학) 18: 99-158.
- Lee, Jongmook (이종묵). 2001. "The Yi Hwang School and Mt. Cheongnyang" (퇴계학과와 청량산). *Symposium in Commemoration of 500th Anniversary of the Birth of Yi Hwang and Jo Sik* (퇴계·남명 탄신500주년기념 학술대회 발표자료집). Seongnam: Academy of Korean Studies.
- Lee, Sangeun (이상은). 1999. *Life and Study of Yi Hwang* (퇴계의 생애와 학문). Seoul: Yemoon Publishings.
- Song, Jaeso (송재소). 2001. "Yi Hwang's Retreat and Collected Poems at Dosan" (퇴계의 은거와 陶山雜詠). *The Journal of Toegye Studies* (퇴계학보) 110: 325-356.
- Toegye Studies Institute at Kyungpook National University (퇴계학연구소). 2000. "Chronology of Yi Hwang: Supplementary" (『退溪年譜』補遺 권2). *Anthology of Yi Hwang* (퇴계전서) Vol. 27. Daegu: Toegye Studies Institute.
- Yi, Hwang (이황). 1843. Chapter 3. "Collected Poems at Dosan" (陶山雜詠并記). *Collected Writings of Yi Hwang* (退溪集).
- Yi, Song-mi (이성미). 2006. *Korean Landscape Painting: Continuity and Innovation through the Ages*. Elizabeth, NJ: Hollym International Corp.
- Yoo, Jaebin (유재빈). 2004. *Study of Dosando* (도산도 연구). MA thesis, Department of Archaeology and Art History, Seoul National University.
- Yu, Jun-yeong (유준영). 1981. "Birth and Function of the Nine Bends Paintings" (구곡도의 발생과 기능에 대하여). *Gogomisul* (고고미술) 151: 1-20.
- Yun, Chinyong (윤진영). 1997. *Paintings of the Nine Bends of the Joseon Dynasty* (조선시대 구곡도 연구). MA thesis, the Academy of Korean Studies.
- \_\_\_\_\_. 1998. "Reception and Development of the Nine Bends Paintings of the Joseon Dynasty" (조선시대 구곡도의 수용과 전개). *Korean Journal of Art History* (미술사학연구) 217/218: 61-91.
- \_\_\_\_\_. 2001. "Yi Hwang and Dosando" (퇴계 이황과 도산도). *Festschrift of Special Lectures on Yi Hwang* (퇴계 이황 특강논문집), edited by Seoul Calligraphy Art Museum, Seoul Arts Center. Seoul: Seoul Calligraphy Art Museum, Seoul Arts Center.
- \_\_\_\_\_. 2006. "Yi I's Nine Bends at Gosan and the Paintings of Nine Bends at Gosan" (율곡 이이의 고산구곡과 고산구곡도). *Poetry, Calligraphy, and Painting of the Family of Sin Saimdang and Her Family* (신사임당 가족의 시서화) edited by Yeongdong Culture Institute at Kwandong University. Gangneung: City of Gangneung.
- \_\_\_\_\_. 2010. "The Retreat Space of Jeong Gu and the Nine Bends of Muheul" (寒岡 鄭述의 유거공간과 <무흘구곡도>). *Korean Studies Quarterly* (정신문화연구) 33-1: 7-48.

## Scientific Analysis of a Goryeo Lacquer Incense Box with Inlaid Mother-of-pearl and Gold-painted Designs

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### I. Introduction

The collection of the National Museum of Korea includes the remnants of a Goryeo lacquer incense box with designs of willows, trees, and ducks inlaid in mother-of-pearl and highlighted with gold paint. The box is one of the only known Goryeo lacquerwares in Korea that has designs inlaid in mother-of-pearl. Moreover, its decorative detailing in gold is exceptionally rare among Goryeo lacquerwares. Thus, in terms of both the design and the decoration technique, this incense box is unparalleled among Korean artifacts from any time period.

Nothing is known about the history or provenance of the box prior to 1910, when it was purchased by the Yi Royal Household Museum (predecessor of the National Museum of Korea) from a Japanese collector named Aoki Bunshichi (青木文七). The box has traditionally been attributed to the Goryeo Dynasty (高麗, 918-1392). Although its intended function cannot be confirmed, it has long been considered to be an incense box, because it was found to contain a flower-shaped incense.

The incense box originally consisted of three primary components: a four-sided outer cover that fit over a four-sided inner box, and an inner tray (懸子) that fit into the box (Fig. 1). At the time of purchase, the box was already damaged from apparently having been buried for an untold number of years, but the three main components seem to have been essentially intact. However, during the Korean War (1950-1953), the box suffered further damage, such that it now exists only as fragments. Thus, its original shape can only be estimated from photographs in *The Illustrated Book on Historical Remains of Korea* (朝鮮古蹟圖譜), which was published during the Japanese colonial era (1910-1945).

Both the box and cover were decorated with diverse motifs, including willows, flowering trees, pebbles, ducks, chrysanthemums, peonies, and floral scrolls. These designs were made by cutting small design elements from thin sheets of mother-of-pearl and turtle shell, then affixing them to a lacquered surface and covering them with several additional coats of lacquer. Metal wires are added to the design via the *pyeongtal* (平脫, Ch. *pingtuo*) technique. After the lacquer has dried, the surface is polished to highlight the designs. In this case, the design elements were crafted in mother-of-pearl, metal wire, and thin sheets of turtle shell.

In 2006, in order to create a plan for the permanent preservation of the Goryeo incense box, the National Museum of Korea began scientifically assessing the damage and investigating its materials and production method. From January 2007 to

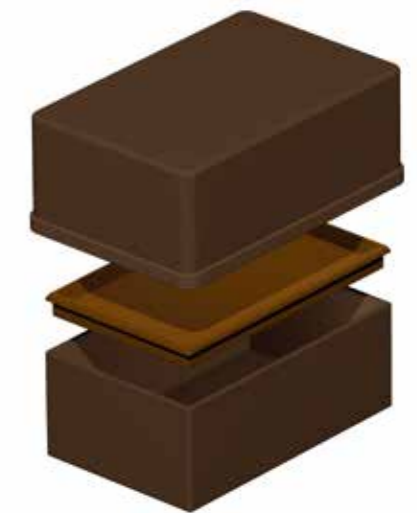


Fig. 1. Three-dimensional diagram of the incense box (from the top: cover, inner tray, and inner box).

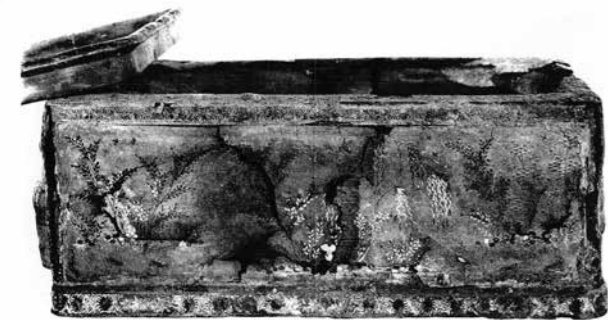


Fig. 2. Cover of the incense box from *The Illustrated Book on Historical Remains in Joseon* (朝鮮古蹟圖譜).



Fig. 3. Inner box of the incense box from *The Illustrated Book on Historical Remains in Joseon* (朝鮮古蹟圖譜).



Fig. 4. Current damaged state of the cover.



Fig. 5. Current damaged state of the inner box.

## II. Current State of the Incense Box

### 1. Condition Report

The extensive damage suggests that the box was buried for a long period. Again, no information is known about the box's origin or its recovery, and details of its condition at the time of purchase can only be inferred based on the photographs from *The Illustrated Book on Historical Remains in Joseon* (Figs. 2 and 3). Those photos show that both the cover and box had sustained significant damage, but were still fairly intact. Unfortunately, during the Korean War, the box was shattered into more than 700 fragments (Figs. 4 and 5). Since that time, the fragments have continued to diminish in size, and a number of fine cracks have spread through the lacquered surfaces. The surviving fragments are now in very poor condition, making them extremely vulnerable to any kind of vibration or movement. Many of the mother-of-pearl and turtle-shell designs have been lost, and are identifiable only by their outlines, while others

December 2008, specialists from Korea and Japan jointly conducted research on the box to determine the best methods for conserving and restoring it. To date, research on the box's constituent materials and production techniques has utilized the following procedures: examination with both optical and scanning electron microscopes (SEM); X-radiography; scanning electron microscope/energy dispersive spectroscopy (SEM/EDS); micro X-ray fluorescence ( $\mu$ -XRF) analyses of the mineral composition of the constituent materials; and attenuated total reflectance-infrared (ATR-IR) analysis of the lacquer-varnishing. Based on the results of this research, the museum has been able to identify various key features of the Goryeo incense box, including the box's shape, composition, and lacquer-varnishing technique. The analyses also revealed important details of the various design elements, which were made with mother-of-pearl, metal wire, pieces of turtle-shell painted with pigments, and gold paint that consists of powdered gold in a binder.

are covered with dirt or other contaminants, making it very difficult to identify their details. In addition, many of the metal-wire designs have been lost, have disintegrated, or are corroded with rust. In addition, the gold-paint designs that were applied over the layer of lacquer have been abraded, making their exact shapes and subjects difficult to discern. Even so, traces of gold paint still present in some areas suggest that the painted designs represented water from a stream, branches of flowering trees, and birds in flight.

### 2. Decorative Scheme

All three components of the incense box were amply decorated with inlaid and painted designs. Until recently, the precise arrangement of the designs could not be determined because of the box's damaged condition. However, the investigative research and scientific analyses have now allowed us to identify and recreate the original layout of the designs (Figs. 6-8). The designs on both the cover and the box were arranged symmetrically, with paired designs on the front and back, or paired designs on the left and right sides. The main designs on the cover and inner box are waterside scenes showing willows (cover only) and different types of flowering trees on the banks of a stream, along with pebbles, ducks, flying birds (Figs. 9-16). Secondary border designs around the sides and edges of the box and cover include chrysanthemum scrolls (cover only), peonies, and X-shaped blossoms resembling pinwheels (Figs. 17-21). The edges on all four sides of the upper surface of the cover are decorated with a horizontal band of chrysanthemum scrolls; similar bands can also be found on the vertical sides of the cover. The bands also feature a few peonies amid the chrysanthemum scrolls. The pinwheel-shaped flowers appear in horizontal bands around the upper and lower edges of the box, and in vertical bands on the box's corners. Notably, the pinwheel-shaped flowers in the bands on the lower edges differ from the others in both form and size. The floor of the inner tray is decorated with chrysanthemum blossoms and stems arranged in latticework patterns (Fig. 22), while the tray's edges feature simplified chrysanthemum blossoms and stems (Fig. 23). The shape and arrangement of the chrysanthemum designs on the floor of the tray resemble those on a Goryeo sutra container with inlaid mother-of-pearl chrysanthemum designs, now in the



Fig. 6. Arrangement of designs on the front and back sides of the cover.



Fig. 7. Arrangement of designs on the front and back sides of the inner box.

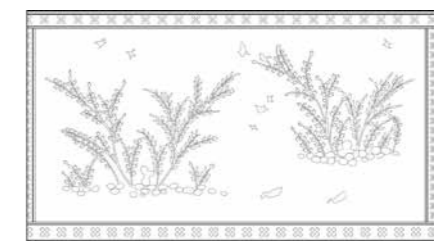


Fig. 8. Arrangement of designs on the left and right sides of the inner box.

collection of the Tokyo National Museum.

## III. Materials and Production Technique

### 1. Physical Dimensions of Fragments

Each of the fragments of the incense box was measured (i.e., length, width, depth, thickness), and, when possible, the measurements were compared to the dimensions recorded in *The Illustrated Book on Historical Remains in Joseon*. The fragments were also photographed to record their condition at the time of examination. In addition, details of the joints were carefully observed in order to determine how the pieces were joined together.

### 2. Photography

All of the relevant designs were photographed at 1 $\times$  and 2 $\times$  magnification with a 65mm lens (equivalent to 5 $\times$  and 10 $\times$  magnification) in order to record the box's present condition and to permit identification of the types and characteristics of the designs



Fig. 9. Willow tree.



Fig. 10. Flowering tree 1 (Turtle-shell designs of red and yellow flowers).



Fig. 11. Flowering tree 2.



Fig. 12. Flowering tree 3.



Fig. 13. Tree (incl. traces of the disintegrated mother-of-pearl pieces).



Fig. 14. Gravel and pussy willow.



Fig. 15. Gilt designs of twigs of a flowering tree and birds.



Fig. 16. Mother-of-pearl designs of ducks and gravels and gilt design of water.



Fig. 17. Chrysanthemum scrolls from the edges of the upper surface of the cover.



Fig. 18. Chrysanthemum scrolls from the band around the vertical sides of the cover.



Fig. 19. Mother-of-pearl peony designs and metal-wire designs from the vertical sides of the cover.



Fig. 20. Pinwheel-shaped flower designs from the upper edge of the inner box.



Fig. 21. Pinwheel-shaped flower designs from the lower edge of the inner box.



Fig. 22. Chrysanthemum design from the interior bottom of the inner tray (incl. traces of the disintegrated mother-of-pearl pieces).



Fig. 23. Chrysanthemum designs from the edge of the inner tray (incl. traces of the disintegrated mother-of-pearl pieces).

[Camera: Canon EOS 5D Mark II, Lens: Canon MP-E 65mm].

### 3. X-radiography

X-ray inspection was undertaken on those fragments that still bear original designs, in order to identify internal damage invisible to the naked eye, to examine the shape and arrangement of the designs, and to determine the direction of the wood grain and the use of a fabric as a base [Instrument: Softex X-ray K2. Parameter: 20 kV, 2 mA, 1 min, distance: 100 cm, Agfa D7 film].

#### 4. Stereoscopic Microscopy and Measuring of Decorative Elements

Details of the mother-of-pearl, turtle-shell, metal-wire, and gold-painted designs were examined with a stereoscopic microscope at 5× to 40× magnification [Leica MZ 9.5 and Leica M205 A]. In order to measure each part of the individual designs, the digital data was processed with image-analysis software [Image-analysis software: Olympus analySIS 5].

#### 5. Transmission and Polarization Microscopy

Transmission and polarization microscopy at 50× to 500× magnification was conducted in order to study the composition and layer structure of the lacquer coatings, the gold-painting technique, the type of wood used, and the material of the fabric base [Instrument: Leica DMLP]. Detached fragments of the lacquer coating and of the wooden frame (2-4 mm in size) were embedded in transparent epoxy and polished to expose the first cross-section of the lacquer layer [Struers silicon carbide paper #500 - #2400]. For microscopic observation, the samples were attached to a glass slide and processed to be as thin as 10-20 μm (0.01-0.02 mm).

#### 6. Scanning Electron Microscopy (SEM)

The samples discussed in the section above, as well as detached samples of the mother-of-pearl and metal-wire designs, were observed with a scanning electron microscope in order to study them in cross-section, and thus examine the composition and layer structure of the lacquer coating, the evidence of processing the mother-of-pearl and metal-wire designs, the shape and dispersion of the gold powder particles in the gold paint, and the fibers of the fabric base [Instrument: Hitachi SEM-3500N, Japan].

#### 7. Scanning Electron Microscope-Energy Dispersive Spectroscopy (SEM/EDS)

The scanning electron microscope was equipped with an energy-dispersive spectroscope, which was used to analyze the composition of the bone-ash layer and the material of the metal wires [Instrument: SEM-Energy Dispersive Spectroscope, Kevex, USA].

#### 8. Micro X-ray Fluorescence Analysis (μ-XRF Analysis)

Because it was difficult to obtain adequate samples of the metal wires and the pigment used to paint the

turtle-shell designs, micro X-ray fluorescence analysis was carried out on those parts [Instrument: Portable μ-XRF Spectrometer, Art TAX, Rontec, Germany, Parameters: 500 mA, 100 sec].

#### 9. Attenuated Total Reflectance-Infrared Analysis (ATR - IR Analysis)

A spectrum of the lacquer was analyzed by ATR-IR and compared to a control specimen in order to identify the type of lacquer used on the incense box [Instrument: ALPHA-E (Bruker Co., Germany), ATR measurement, ATR crystal type: ZnSe (Zinc Selenide)].

### IV. Results

#### 1. Physical Dimensions of the Incense Box

The box's original dimensions were estimated based on measurements of the extant fragments (Figs. 4 and 5). When possible, the estimated measurements were compared to data recorded in *The Illustrated Book on Historical Remains in Joseon*, with the *chon* (寸) unit converted into millimeters. For example, the depth (or height) of the box (103 mm) was found to be similar to the previously recorded data. Again, the box has three primary components: the inner box, the cover, and the tray, which fits inside the box. The cover is 293 mm long, 194 mm wide, and 112 mm deep. On one side of the cover, there is a protruding band measuring 15 mm in width and 3 mm in thickness. The inner box is 271 mm long, 171 mm wide, and 103 mm deep. The tray measures 22.7 mm in depth; its length and width are commensurate with those of the inner box (Figs. 24-25).

#### 2. Materials and Method of Assembling the Box

The incense box is made from quarter-sawn pieces of wood from a coniferous tree. The exact species has not been identified, but based on the presence of taxodioid pits, it is assumed to be of genus *Abies* or *Thuja*. The wood pieces forming the four sides of the cover were joined at their edges and then firmly connected to each other by means of a triangular wooden support set in each corner; the sides of the inner box were assembled in similar fashion. Once the sides had been joined, the pieces for the top (of the cover) and the floor (of the inner box) were attached. The cover's top was affixed to its sides with wooden

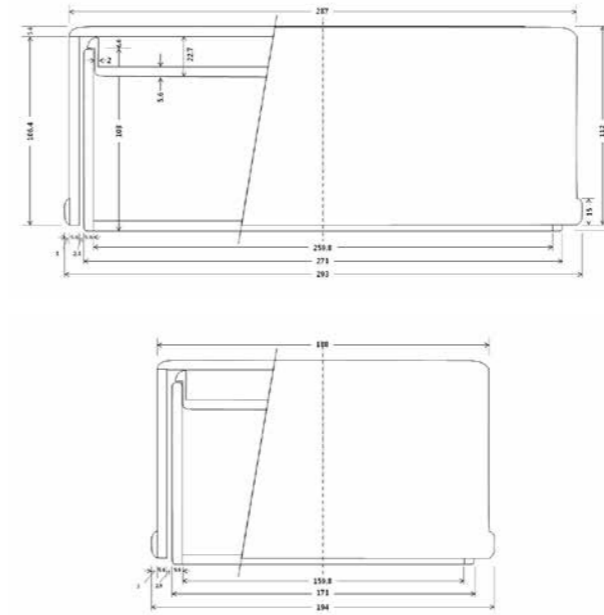


Fig. 24. Longitudinal cross-section of the incense box.  
Fig. 25. Transverse cross-section of the incense box.

pegs; by contrast, no pegs were used to connect the floor, which is simply an inserted panel.

#### 3. Results of X-ray Photography

X-ray photography revealed many elements that were hard to see with the naked eye, including the metal wires, the mother-of-pearl and turtle-shell designs, the fabric base, the direction of the wood grain, and fine cracks in the lacquer coating (Figs. 26-30).

#### 4. Type of Lacquer and Lacquer-Varnishing Technique

**4.1) Type of Lacquer:** ATR-IR analysis of the lacquer specimen revealed a broad absorption band at 3600-3200  $\text{cm}^{-1}$  due to a phenolic hydroxyl (-OH) group and a weak absorption band at 2900-2800  $\text{cm}^{-1}$  due to the stretching vibration of the C-H bond of a methylene group. The analysis also showed the existence of a broad absorption band near 1730-1600  $\text{cm}^{-1}$ , apparently resulting from the stretching vibration of the C=C bond, the skeletal vibrations of the aromatic ring, and the stretching vibration of the C=O bond. Absorption bands at 1450  $\text{cm}^{-1}$  from a methylene group and at 990  $\text{cm}^{-1}$  from conjugated trienes were also observed, which confirms that the specimen is a polymer. The spectrum was similar to that of typical lacquer with a primary component

of urushiol (漆酚). At certain bands, the absorption spectrum was somewhat weaker than those of the control specimen, which is attributed to the deterioration and contamination of the lacquer layer and the bone ash mixed with the lacquer (Figs. 31 and 32).

**4.2) Lacquer-Varnishing Technique:** The wood panels were first primed with an undercoat of lacquer that permeated the surface, and then covered with a fabric base. Next, a layer of bone ash was applied over the fabric base, followed by an outer layer (or top coating) of lacquer. The combined thickness of the bone-ash and outer-lacquer layers is 500-600 μm, with each layer comprising approximately half the thickness. The bone-ash consists of lacquer and bone-meal powder of indeterminate forms smaller than 110 μm. The fabric base is 300 μm thick and made from plain-woven silk (density: 28 x 20/cm). The topcoat layer of lacquer (over the bone-ash layer) is around 30-40 μm thick, and the transparent lacquer was applied two or three times in most areas (Figs. 33-35).

#### 5. Decorative Techniques

**5.1) Mother-of-pearl Designs:** Mother-of-pearl was used to create various designs on the inner box (e.g., pinwheel-shaped flowers); on the cover (willows, pebbles, flowering trees, ducks, peonies and scrolls in the band); and on the tray (chrysanthemums). The material for these mother-of-pearl designs came from thin shells (presumably abalone), and is around 0.3 mm in thickness. Given that fretsaws were not yet in use at that time, the designs were likely cut from the shells using small knives or engravers, or perhaps by using gimlets to make small holes in the shape of the desired design. The cut shells would then have been trimmed with polishing tools (including wires). In some areas, the mother-of-pearl designs have fallen away, exposing the fabric base. Microscopy on the lacquer layer around the mother-of-pearl designs did not detect any bone ash between the mother-of-pearl designs and the fabric base, suggesting that the inlaid elements were attached directly to the fabric base solely by means of the lacquer undercoating, without an intervening layer of bone ash (Figs. 36-38).

**5.2) Turtle-shell Designs:** Several colored designs were made with thin sheets of turtle shell that were

Figs. 26–30. X-ray photography.

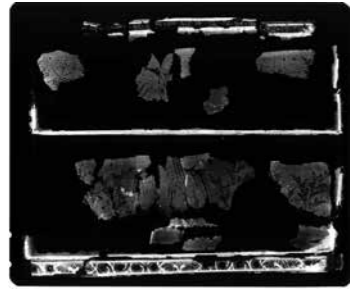


Fig. 26. The front and back sides of the cover.

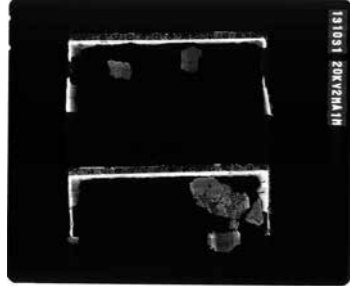


Fig. 27. The left and right sides of the cover.

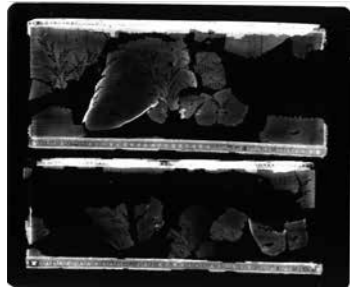


Fig. 28. The front and back sides of the inner box.

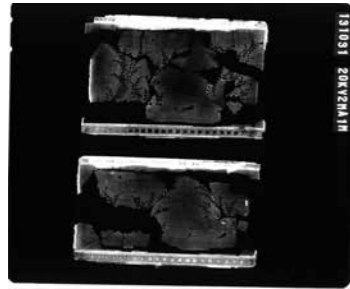


Fig. 29. The left and right sides of the inner box.

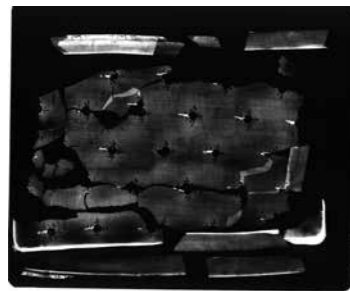


Fig. 30. The top of the inner tray.

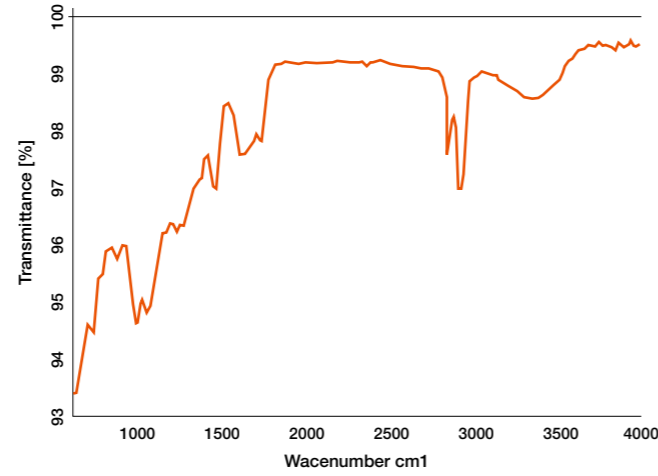


Fig. 31. Infrared absorption spectrum of the control specimen (mixture of bone ash, Japanese raw lacquer, and refined lacquer).

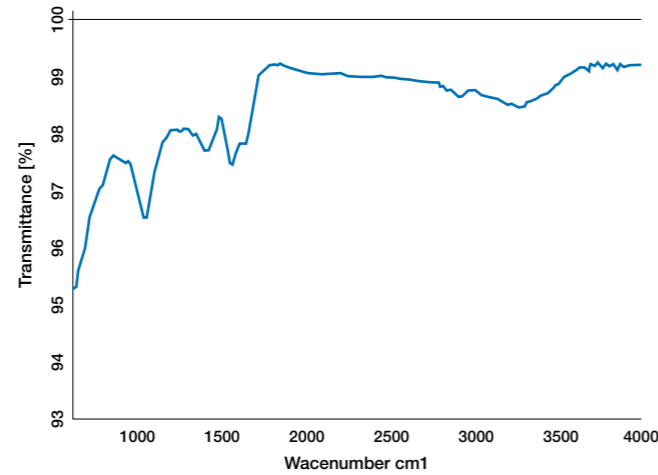


Fig. 32. Infrared absorption spectrum of the lacquer on the incense box.

Painted on the underside. Those designs include the star-shaped flowers of the flowering trees on the cover and box, the chrysanthemums on the edges and bands of the cover, and the pistil of the chrysanthemum at the bottom of the inner tray. According to XRF analysis, the yellow petals and red pistil of the chrysanthemum designs in the cover were made with orpiment ( $As_2S_3$ ) and cinnabar ( $HgS$ ), respectively. On the inner tray, turtle-shell sheets painted with orpiment were used to make the chrysanthemum pistil, which is surrounded by petals made from mother-of-pearl. Cinnabar was used for most of the star-shaped flowers on the ends of the flowering trees' branches, but the yellow flowers were again made with orpiment (Figs. 39-41).

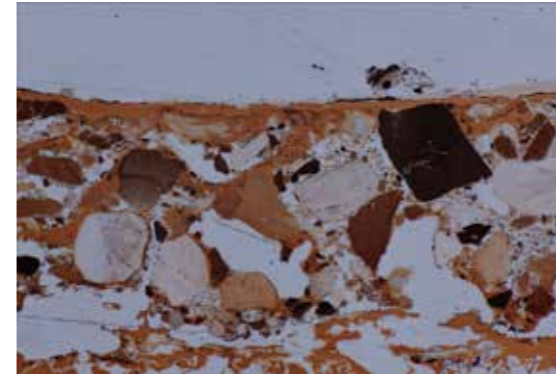


Fig. 33. Cross-section of the lacquer layer (Transmission light microscope x100).

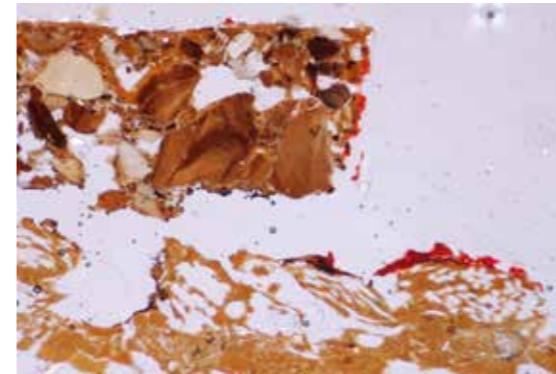


Fig. 34. Cross-section of the lacquer layer around the turtle-shell designs (Transmission light microscope x100).



Fig. 35. Weaving of the fabric base (SEM of the backside of the lacquer layer).

**5.3) Metal-wire Designs:** The box features a number of designs made with metal wires, some of which were made with a single wire and some of which were made with two wires twisted into a single strand. Metal wires were used to create the borders around the designs, as well as for the borders on the sides of both the inner box and cover. In addition,

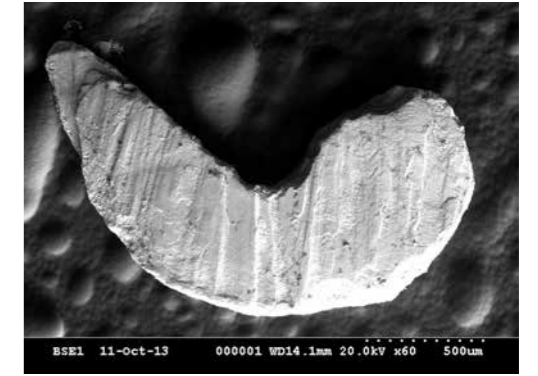


Fig. 36. Backside of the mother-of-pearl scroll leaf design (SEM).

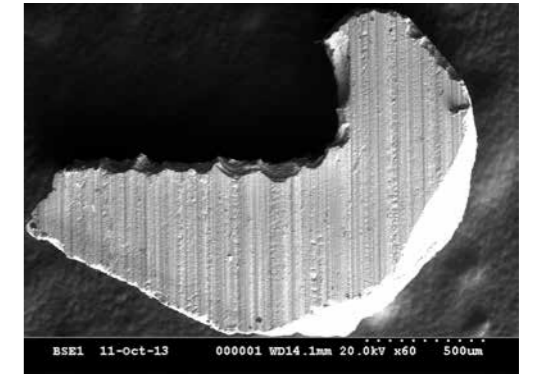


Fig. 37. Sample of mother-of-pearl cut with a fretsaw (SEM).

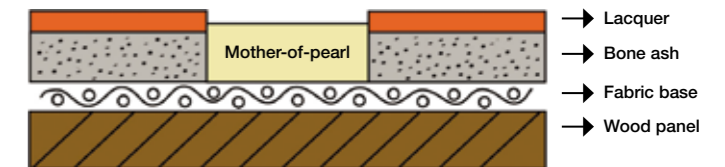


Fig. 38. Cross-sectional diagram of areas inlaid with mother-of-pearl design



Fig. 39. Turtle-shell chrysanthemum designs from the edges of the upper surface of the cover.



Fig. 40. Fluorescent X-ray analysis spectrum of the red part of the turtle-shell design (Major composition: Hg).



Fig. 41. Fluorescent X-ray analysis spectrum of the yellow part of the turtle-shell design (Major composition: As).

wires were used to render the scrolls' stems, the stalks of the peonies, and the eye-like outlines in the band along the lower edge of the cover. Finally, wires were also used to make the stalks of the chrysanthemums on the tray. According to XRF and SEM-EDS analysis, the single wires have a diameter of 0.5-0.6 mm and were made by forging a thin metal plate of an alloy of tin (Sn) and lead (Pb) (Figs. 42, 43, and 44). The twisted double wires consist of a pair of

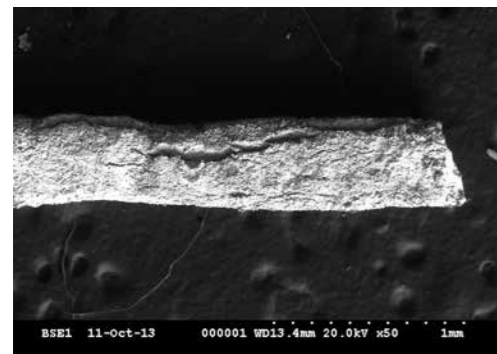


Fig. 42. Side of the forged wire (SEM).

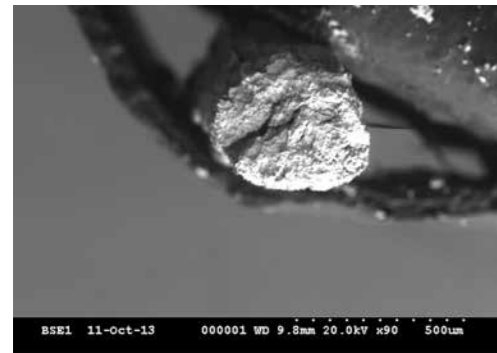


Fig. 43. Cut of the forged wire (SEM).

round wires that are 0.3 mm in diameter and are composed of a brass alloy of copper (Cu) and zinc (Zn) (Figs. 45-48).

**5.4) Gold-painted Designs:** Gold paint was used to express the branches of some flowering trees, the water flowing around the pebbles, and the birds in flight. Analysis determined that gold leaf was ground into powder to create the gold paint for those designs. The gold powder was likely made via one of two known methods. The first method involves placing gold leaf into a powder container (typically a bamboo segment) with a screen or mesh fitted over the open end, and then using a brush or other implement to force the gold leaf through the mesh, thereby rendering it into a powder. A somewhat more elaborate method is described in the section "How to use color," from the first fascicle of *Jie zi Yuan hua zhuan* (芥子園畫傳, *The Mustard Seed Garden Manual of Painting*) compiled by Wang Gai (王概, 1645-1707). According to that text, gold powder could be made by applying glue to a porcelain vessel and then placing a sheet of gold leaf atop the glue. Once the glue had dried, the gold could be rubbed off by hand, forming tiny powdered granules. Notably, transmission, reflection, and polarization microscopy failed to identify any traces of adhesive (presumably lacquer) in the areas between the gold particles; as such, it is unlikely that the gold powder was either mixed with lacquer and directly applied, or scattered over moist lacquer that had been applied to the surface in the form of the designs. Therefore, it is estimated that the gold-painted designs were made with gold powder mixed with some type of glue (perhaps fish or hide glue), or else with drying oil (Figs. 49-52).

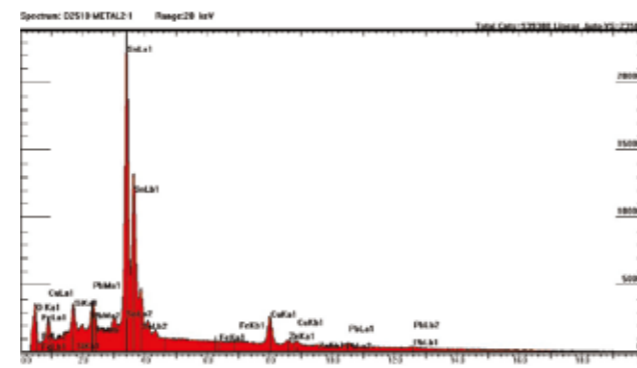


Fig. 44. SEM-EDS analysis spectrum of the solid wire (Sn, Pb).



Fig. 45. Double-stranded wire.

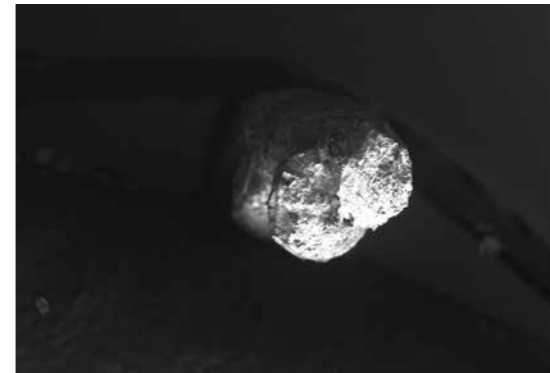


Fig. 46. Cut of the double-stranded wire (SEM).

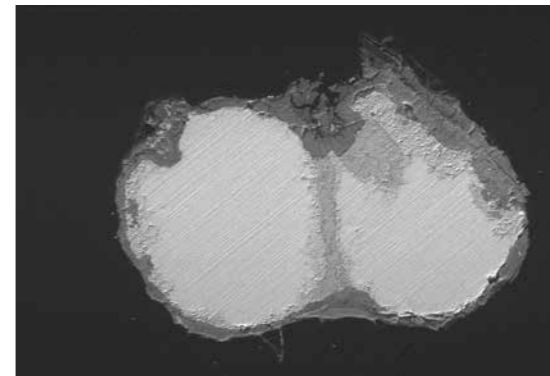


Fig. 47. Cross-section of the double-stranded wire (SEM).

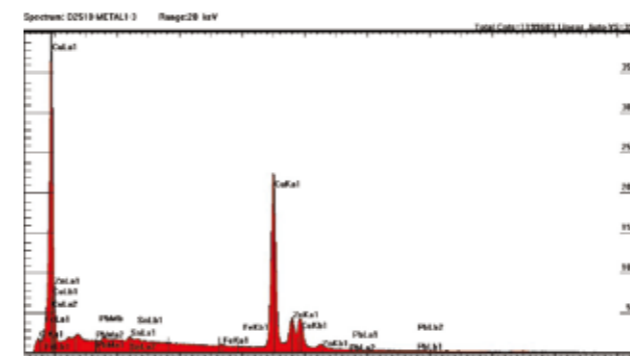


Fig. 48. SEM-EDS analysis spectrum of the double-stranded brass wire (Cu, Zn) composition.

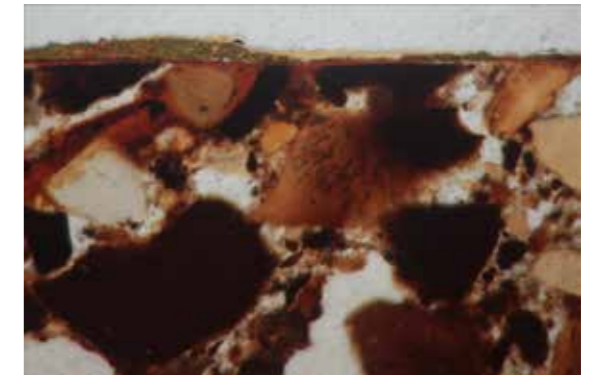


Fig. 49. Cross-section of the lacquer around the gilt designs (reflection microscope x200).

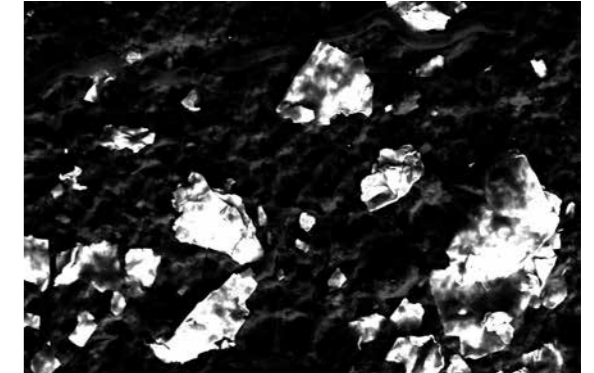


Fig. 50. Surface of the gilt designs (SEM).

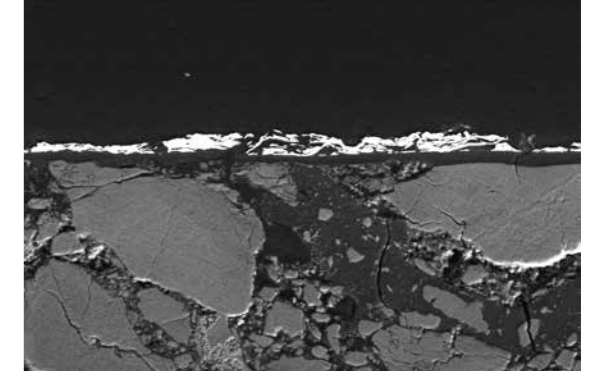


Fig. 51. Cross-section of the lacquer around the gilt designs 1 (SEM).



Fig. 52. Cross-section of the lacquer around the gilt designs 2 (SEM).

## V. Conclusion

The Goryeo lacquer incense box with inlaid mother-of-pearl and turtle-shell designs of willows, flowering trees, and ducks and gold-painted designs was made by a method called *moksimjeopichilgi* (木心苧皮漆器). Analysis determined that the incense box was made from quarter-sawn pieces of wood that were covered with fabric, followed by a coating of bone ash mixed with bone meal powder, and finally an outer layer of lacquer.

The mother-of-pearl designs appear to have been made by cutting abalone shells (around 0.3 mm thick) into the desired shapes with gimlets or small knives. Some colored designs were made from thin sheets of turtle shell painted with pigment made from cinnabar or orpiment. Other designs were inlaid with metal wires, consisting either of single metal wires made from an alloy of tin (Sn) and lead (Pb), or twisted pairs of round wires made from a brass alloy of copper (Cu) and zinc (Zn). The gold-painted designs are believed to have been painted with a pigment made from gold powder that was likely mixed with glue or a drying oil, and then applied over the existing designs.

All of the research results suggest that the incense box was produced using the highest quality materials and the most advanced techniques of the day. Despite its fragmented condition, this artifact thus has great value for the study of early lacquerwares, as it offers significant evidence of the most advanced techniques for producing lacquerware at the time. In particular, the data obtained through this research will be of great use in the conservation and restoration of lacquerwares from the Goryeo Dynasty, including this incense box. Even so, further research will be required to determine several additional points, including the type of wood used to make the box, the alloy ratio of the dissimilar metals, the methods for making and applying the gold paint, the type of shell used for the mother-of-pearl designs, and the tools used to make the designs. ㄸ

TRANSLATED BY CHUNG EUNSUN

This paper is an edited and abridged English version of “Investigation of Gold-Painting Technique in the Lacquerwares of Goryeo,” previously presented in a 2013 international symposium on the Goryeo lacquer incense box with inlaid mother-of-pearl and gold-painted designs, held at the National Museum of Korea.

## Selected Bibliography

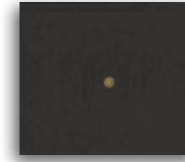
- Gwak, Daeung (곽대웅) and Hwang, Jihyeon (황지현). 2006. “Korean Lacquerwares Inlaid with Mother of Pearl” (한국의 나전칠기). *Catalogue of Korean Lacquerwares: The Everlasting Beauty* (나전칠기·천년을 이어 온 빛). Seoul: National Museum of Korea.
- Gwak, Daeung (곽대웅). 1984. *Lacquerwares of the Goryeo Dynasty* (고려나전칠기 연구). Seoul: Mijinsa.
- Park, Junghae (박정혜) and Yi, Yonghee (이용희). 2013. “Gold-painting Technique in the Lacquerwares of Goryeo” (고려시대 칠기에 나타난 모금기법연구). *Conservation Science in Museum* (박물관보존과학) vol. 14. Seoul: National Museum of Korea.
- Yi, Yonghee (이용희) and Seo, Jeong-ho (서정호). 2010. “Techniques of Ancient Korean Lacquerwares” (고려시대 이전에 제작된 출토 고대칠기의 칠 기법 연구). *Journal of the Korean Society of Cultural History* (문화사학회지) vol. 33. Seoul: The Korean Society of Cultural History.
- Yi, Yonghee (이용희), Kim, Kyoungsu (김경수) and Yu, Heisun (유혜선). 2003. “The Manufacturing of Lacquerware Objects of Nangnang I” (낙랑칠기의 칠기법 조사 I). *Conservation Science in Museum* (박물관보존과학) vol. 4. Seoul: National Museum of Korea.
- Yi, Yonghee (이용희), Kim, Kyoungsu (김경수) and Yu, Heisun (유혜선). 2009. “Characteristics of Lacquer-Varnishing Technique of Lacquerware Relics Excavated from Daho-ri” (다호리 출토 칠기유물의 칠기법 특징 연구). *Journal of Archeology*, Special Edition (고고학지 특집호). Seoul: National Museum of Korea.
- Yi, Yonghee (이용희). 1994. “Materials and Techniques of Lacquerware Production of the Unified Silla Period” (통일신라시대 칠기의 재질과 기법). *Proceedings of the Korea-Japan Joint Research on Conservation Science* (한·일 보존과학 공동연구 자료집). Daejeon: National Research Institute of Cultural Heritage.
- \_\_\_\_\_. 1996. “Restoration Report on the Chosun Dynasty Lacquered Wares Inlaid with Mother-of-pearl” (조선시대 나전칠기 수리). *Journal of the Korean Conservation Science for Cultural Properties* (보존과학학회지) vol. 5, no. 2. Chungnam: The Korean Society of Conservation Science for Cultural Heritage.
- Yun, Wonsun (윤원선). 2004. *Expressive Craft Made Using Gold Dust and Leaf on Buddhist Painting* (불화의 금니·금박 표현기법 연구). MA Thesis, Graduate School of Art, Yong In University.

## Further Reading

### NATIONAL TREASURES: METAL CRAFTS

국보 금속공예

Daejeon: Cultural Heritage Administration (2008).



Part of the *Overview of Korean Cultural Heritage* series published by the Cultural Heritage Administration of Korea, this book includes photos and descriptions (incl. materials, period, and dimensions of each object) of forty-six metal crafts that have been designated as National Treasures. The book is divided into two sections—general metal crafts and Buddhist metal crafts—with each section organized chronologically. The general metal crafts section includes bronze ritual vessels and weaponry, as well as various gold artifacts. In particular, the Silla gold crowns, belts, necklaces, and earrings and the Baekje metal crafts from the Tomb of King Muryeong exemplify adept casting techniques and resplendent aesthetics. The Buddhist metal crafts section introduces masterpieces such as the Baekje gilt-bronze incense burner, decorative Buddhist reliquaries, a Unified Silla Buddhist bell, and a Goryeo incense burner. This book provides an excellent introduction to the advanced techniques and aesthetics of Korean metal crafts.

ISBN: 9788963250205 (311 pages, in Korean).

### THE GLORY OF KOREAN INLAID METAL ARTS

우리나라 금속공예의 정화, 입사공예

Seoul: National Museum of Korea (1997).



This catalogue was published to accompany a special exhibition of the same title held at the National Museum of Korea in 1997. *The Glory of Korean Inlaid Metal Arts* was the first major exhibition in Korea to focus on inlaid metal crafts, presenting about 130 pieces featuring various uses of the metal inlay technique, dating from the Three Kingdoms Period through the Joseon Dynasty. The items documented in the catalogue include a ring-pommel sword excavated from a tomb of the Three Kingdoms Period, resplendent stirrups from the Unified Silla Period, Buddhist ritual implements from the Goryeo Dynasty, and various utensils and equipment for daily living in the Joseon Dynasty. Including plates and descriptions of the artifacts from the exhibition, as well as detailed articles on the metal inlay technique and the decorative patterns of Korea, this catalogue provides readers with an in-depth understanding of the metal inlay technique of Korean metal crafts.

(178 pages, in Korean).

Yi Nanyeong

### METAL CRAFTS OF KOREA

한국 고대의 금속공예

Seoul: Seoul National University Press (2012).



Following the original edition published in 2000, the second edition of *Metal Crafts of Korea* includes a new section on Joseon metal crafts as well as many new supplementary materials in the other sections, gathered by author Yi Nanyeong over the twelve-year interval between publications. This book charts the history of metal crafts in Korea by examining how the function and use of metal crafts changed and expanded over time, from bronze weaponry to household items and accessories. This title is ideal for readers looking for a comprehensive and systematic overview of Korean metal crafts, tracing their chronological development from prehistory through the Three Kingdoms Period, Unified Silla Period, Goryeo Dynasty, and Joseon Dynasty.

ISBN: 9788952113429 (417 pages, in Korean).

### MAJESTIC DECORATION OF BUDDHIST SARIRA RELIQUARIES

불사리장엄

Seoul: National Museum of Korea (1991).



This catalogue was published in conjunction with a special exhibition of the same title held at the National Museum of Korea in 1991. *Majestic Decoration of Buddhist Sarira Reliquaries* focuses on Buddhist reliquaries as the essence of Buddhist religion, aesthetics, and art. Various examples of reliquaries are presented chronologically, from the Three Kingdoms Period through the Joseon Dynasty. Sarira reliquaries, along with accompanying offerings, represented the embodiment of the Buddhist faith of their time, as well as magnificent artworks exemplifying the splendor and mastery of Korean metal crafts. This catalogue includes plates and descriptions of the artifacts from the exhibition, along with related articles and a list of other important Buddhist reliquaries of Korea, serving as a useful resource for both scholars and the general public. Within the context of Buddhist reliquaries, the publication enables readers to explore the significance, diversity, and overall development of Buddhist offerings in Korea.

(265 pages, in Korean).