

# **Traditional Korean Papermaking: analytical examination of historic Korean papers and research into history, materials and techniques of traditional papermaking of Korea**

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## **INTRODUCTION**

Traditional handmade paper was an indispensable material of daily life in Korea. The versatile use of paper can be easily seen in Korean culture throughout its history. Traditional handmade Korean paper was used for calligraphy, books, and envelopes; for doors, walls, and windows; for furniture, such as wardrobes, cabinets, and chests; for craft objects, such as writing brush holders, umbrellas, lanterns, boxes, baskets, fans, and kites; and for clothing and shoes. Koreans seem to be the only people who have been using paper for their floors.

It is believed that paper was invented by Ts'ai Lun in 105 CE in China. Papermaking skills were passed on to Korea and from there were carried to Japan. As a result, the papers of these three countries have certain similarities. Currently traditional Japanese papers are an essential material in paper conservation, and, therefore, have been fairly well investigated. However, not many people know how Korea contributed to the development of papermaking or what kinds of paper Koreans have produced.

Old Chinese books state that Korean paper was regarded as one of the best by Chinese scholars from the tenth century on. Due to its excellent quality, Korean paper had long been one of the main tribute products levied by China. It is interesting that despite flourishing paper manufacturing in China, Korean papers were also exported to China for sale from the Koryo Dynasty (936 – 1392) on.

Since Korea was opened to the Western world, many traditions have declined, including traditional papermaking. There are still a few papermakers producing papers in the traditional way in Korea, but it has been difficult for them to earn a living because the traditional way of papermaking is so laborious and the market is limited. The aim of this research is to review the history, materials, and tools used in traditional papermaking. Some old Korean paper samples have been analyzed using a polarizing microscope and a scanning electron microscope (SEM) to obtain close observations of each sample.

## **THE HISTORY OF PAPERMAKING IN KOREA**

The origin of papermaking in Korea is not known as no written records have been handed down. However, papermaking skill must have spread from China to neighboring countries at an early stage. Some domestic and foreign scholars hypothesize that papermaking might have existed in Korea as early as the third century or at least before the end of the 6th century. The belief that Korea started using paper before the 4th century is based on a piece of paper unearthed from the 116th ancient tomb, Chechubchong, by the Choson Archaeological Site Research Group in 1931. As this tomb belonged to the Naknang period (108 BCE – 313 CE), it is possible to say that at least around the beginning of the fourth century papermaking was carried out in Korea. In 610 Damjing, a Korean Buddhist monk, introduced papermaking skills to Japan along with ink sticks, a millstone, and coloring methods. As a result, by the late 6th century papermaking skills in Korea must have been well developed.

### **The Era of the Three Kingdoms (1st century BCE – 7th century CE)**

Goguryeo (39 BCE – 668 CE) was a large Korean kingdom established during the 1st century BCE, and it governed the northern part of the Korean peninsula. Baecze and Sinla were rival kingdoms that controlled the southern part of the Korean peninsula, dividing it into east and west. It is believed that the kingdom of Goguryeo started to record its history from the beginning of its era and left Yugi, 100 volumes of written history. The kingdom of Baecze compiled its history at the end of the 4th century and Sinla did the same in the middle of the 6th century. There are no records of papermaking during this era, but it can be presumed that by that time traditional papermaking skills were well developed; otherwise it would have been impossible to supply the large amount of paper needed to satisfy the demands of writing so many history books. Although the kingdom of Sinla was the latest in terms of cultural development, eventually it conquered the other two kingdoms and unified them in 668CE. This period is called Tongil-Sinla and

presents valuable historic remains. For example, the earliest known extant printed Buddhist text, Dharani Sutra, was found at the Pulguk Temple in Kyungju, which was the capital of Tongil-Sinla. It was inside a stupa sealed in 751 CE. Moreover it was found with a record that had the exact date when this project was started, and the papermaker's name. During its conservation, it was confirmed that the paper had been made of paper mulberry, which Koreans term dac.

### **The Koryo Kingdom (918 – 1392)**

As the prosperity of Tongil-Sinla declined because of civil war during the early 10th century, the last king of Tongil-Sinla surrendered to a newly rising kingdom, Koryo. During this period, the publishing of all kinds of books flourished, including Buddhist texts, medical and history books. Paper money was also issued. It was the golden age of papermaking and publishing, especially during the 11th and 12th centuries. As a result, the demand for paper increased and the Koryo government exhorted farmers to cultivate paper mulberry throughout the country from 1145 on, and also encouraged people to make paper.

Koryojee, the paper made in Koryo, was frequently mentioned in literature and history books in China as koryojee gained fame among scholars and emperors due to its excellent quality[1]. It is said that it was thick, strong, and white and its surface was lustrous due to the traditional finishing process, chujibub.

Having Buddhism as the state religion, the Koryo government sponsored many Buddhist activities. One of its important achievements was the publication of the Tripitaka, the Buddhist sutras and commentaries, despite being at war with the Mongol empire in the 13th century. The total number of woodblocks for one set of the sutras came to 86,686, and 162,890 sheets of paper were needed for printing the Korean edition of the Tripitaka[2]. It was also during this period that the first movable metal typeface was invented in Koryo. Although the exact date of the invention is difficult to identify, many scholars speculate that it was more than 150 years before Gutenberg used movable type in the 15th century. The earliest text printed was Jikjisimcheyojeol done in 1377. It is kept in the French National Library in Paris.

The downfall of the Koryo kingdom came about because of the intolerably heavy tribute duty demanded by the Mongols. Papermaking started to decline with the waning of the Koryo kingdom.

### **The Chosun Kingdom (1392 – 1910)**

The Chosun kingdom that replaced the Koryo kingdom, was a neo-

Confucian state. During its approximately 500 years, many literary and philosophy books were published. From the beginning of this kingdom, there was an effort to revive papermaking skills by establishing a papermaking department operated by the government. However, because of the increasing popularity of publishing a wide range of books, there was a lack of material. The Chosun government sent papermakers to China to learn their papermaking methods using different raw materials and also imported materials from Japan; in 1430 King Sejong sent an envoy to Daema Island to get fine Japanese mulberry for cultivation[3]. A wide range of different raw materials, such as pine tree bark, rice straw, and bamboo, were used for papermaking. Although this was not the first time that other materials had been mixed with paper mulberry, such mixtures became more common from this period on.

The peaceful era of the early Chosun culture ended in 1592 when the Japanese invaded after Japan was newly-unified under Hideyoshi Toyotomi. During the six years of war, Hideyoshi and his generals pillaged the Chosun cultural properties, and many craftsmen were taken as slaves and transported to Japan. The papermaking industry was greatly damaged by this invasion since it was based on the labor of farmers in the agricultural off season. After this war the government pressured Buddhist monasteries to supply paper as monks were already producing papers for religious texts. At the same time, a heavy tribute of paper was demanded by China during the Yuan, Ming, and Ching dynasties. All these factors exhausted the papermaking industry, and the quality of paper produced in this period declined. It was near the end of this period when western paper equipment was brought to Korea from Japan by a Korean government official in 1884[4].

## **THE KOREAN PAPERMAKING PROCESS**

There is not much written information on how the traditional papermaking process has varied over time, but the principles employed seem to be much the same. One-year-old dac (Korean term for paper mulberry, *Broussonetia kazinoki* or *Broussonetia Papyrifera*) is usually harvested between November and February when the fibers of the inner bark are well formed and the moisture content of the bark is sufficient to make it easier to peel. When dac is cut, the diagonal cross section should face toward the south since it is believed that will help dac sprout well the next year.

The steaming process makes it easy to remove the skin of the harvested dac. Two connected, gourd shaped pits are dug in a field in the shape of a gourd. In the bottom of the smaller pit, bunches of firewood are piled and

small stones are put on top of them. The larger pit is filled with the harvested dac, which is laid one on top of another and then covered with branches of pine and the pit is sealed with soil. After that the firewood in the smaller pit is lit. By the time the wood is almost burned, the stones become very hot. Then the smaller pit is covered with soil and the fire extinguished with water. The heat of the stones turns the water to steam, which moves quickly through the connection to the larger pit. This will cook the dac and soften it.

Next the outer bark is removed. The outer bark is made up of three layers – the brown outmost layer, the middle green layer, and the inner whitish layer. The softened outer bark is removed by hand; the bottom part of the branch is grabbed with one hand and the outer bark is peeled off in strips with the other hand. The removed outer bark is called jopee or peedac, and the outer bark with the top layer removed is called nocpee (noc means green). The innermost layer of the outer bark is called baecpee.

Then the jopee is soaked in a stream for about ten hours, and the brown outmost layer and the green middle layer are peeled off with a knife to obtain the white inner bark. At this stage, it is very important not to leave any dark spots, such as are formed near nodes or from damaged bark.

In order to obtain lye for cooking fiber, traditionally the stems of plants, such as soybeans and chili or the husks of buckwheat, are burned. A big pot with holes in its bottom has a piece of fabric placed in it. Then the ashes are put into the pot and warm water is poured over it. The cloth acts as a strainer to gain a clear liquid form of alkali. The liquid is collected and its initial pH is approximately 10 to 12. Sometimes lime is also used along with wood ash. Nowadays soda ash (sodium carbonate,  $\text{Na}_2\text{CO}_3$ ) or caustic soda (sodium hydroxide,  $\text{NaOH}$ ) replaces potash from wood ash.

The white inner bark is soaked for a day again, and then roughly cut with a sickle to prevent its getting entangled during cooking. Then it is put into a big pot with the prepared alkali and boiled for 4 – 6 hours. Then the cooked fiber is put into a stream for half a day to remove the excess lye and substances dissolved in the lye. During rinsing it is also bleached by sunlight. It is turned regularly for even bleaching. This takes about five days with lots of sunshine. After this process any dark spots are removed by hand once again. The bleached fiber is taken from the water and squeezed. It is put on a flat stone and pounded with a wooden club until it is well spread out and softened. The beaten fiber is called dacjuc.

The prepared dacjuc is put into a rectangular wooden container filled with water, and it is stirred with a bamboo stick and mixed thoroughly to break

up the floccules of pulp. After that, dacpul, a mucilaginous starch extracted from the root of *Hibiscus manihot* L., is added to help the fibers disperse evenly and prevent them from sinking in the water during the sheet formation process. Too much dacpul will delay drainage and the sheet will become very thin, whereas too little dacpul will bring faster drainage and accordingly the sheet will be very thick.

The traditional way of sheet formation is called whabaldugee and it is one of the features that differentiates the Korean papermaking technique from other Asian methods. The papermaking screen rests upon the mould frame. During the process the craftsman holds the screen and the mould together. The far side of the mould is attached to a string hung from above. The craftsman scoops the vat stock from his side first and he lets it flow towards the far side by slanting the mould. This first scoop forms the ground of the sheet. The second scoop is taken laterally from either side and it flows away to the opposite side by slanting the mould. This is repeated until the desired thickness is achieved. Unlike a Japanese mould, there is no deckle on top of the screen to contain the stock, after dipping there is only enough time to allow a change of direction before the stock discharges off the opposite side. As a result the sheet formation process should be done quickly and this technique requires experience and skill to master. Due to this method, the paper on the craftsman's side is usually thicker and gradually gets thinner toward the far side.

When a sheet is formed, the screen is taken from the mould frame. The screen is turned over and put on a prepared flat place. A round wooden log is lightly rolled over the screen to squeeze excess water from the sheet and then the screen is carefully lifted in a rolling motion, leaving the newly formed sheet of paper smooth and unwrinkled. The paper formed in this way is called ilhabjee, meaning one-ply paper. As one side of the paper is slightly thicker than the other, in order to achieve an even thickness throughout a sheet, during the couching the papers are piled in such a way that one sheet is laid down and the next is put on top from the opposite direction. These two sheets make one piece of paper called eehabjee, meaning two-ply paper. The sheets of paper are stacked in a pile, but each completed two-ply paper is marked with a thread to make it easy to separate them later. For drainage the stack of sheets is covered with a thick board and weighted with stones overnight. Later the sheets are separated and put on wooden boards for drying in the sun. These days steam heated stainless steel dryers are generally used for drying.

Finally, every ten dried sheets are piled up and overlapped with one damp sheet until about one hundred sheets are piled together. Then the stack is covered with a thick wooden board and weighted with stones. It is left for a

day to allow the moisture to spread evenly throughout the whole stack. The stack is uncovered and beaten with a wooden club about 200 – 300 times and then the upper half of the pile of sheets are changed with the bottom half. They are beaten again the same way. Then they are left in a shady place for half a day, and later they are beaten 3 – 5 more times depending on the degree of wetness. The craftsman decides how many times the stack of sheets should be beaten. Through this process the surface of each paper becomes smooth and the fibers closely packed together. Sometimes diluted rice starch paste is applied to the surface of the paper as a sizing material.

## **MATERIALS**

There are only bits and pieces of information on the materials used over time in traditional papermaking in Korea. However, paper mulberry has clearly been the main material since the eighth century. There are two main kinds of paper mulberry in Korea: *Broussonetia kazinoki* Sieb and *Broussonetia papyrifera* (L) Vent. Both belong to the Moraceae family and are native to Korea, Japan and China. However, over time some have crossbred with other varieties and it is rather difficult to characterize some of them. Paper mulberry grows naturally throughout the country to a height of about three meters. *Broussonetia kazinoki* is called chamdac in Korean and *Broussonetia papyrifera* (L) Vent is called kuzinamu in Korean.

Formation aid has been used by Koreans from early days due to their unique sheet formation technique. *Hibiscus manihot* L. appeared to become more common from the middle of the 19th century, but before that elm tree bark along with a plant that belongs to the mallow family but is not *Hibiscus manihot* L. was used[5]. Its name in Korean is dacpul. There are 2 – 3 species and all of them are planted during May and harvested in October or November. The flower is light yellow or white with a dark purple center. The viscous liquid from its roots is indispensable for traditional Korean papermaking. It prevents mulberry fibers from entangling and at the same time makes them disperse evenly in water during sheet formation.

One of the traditionally used yellow dyes is *Phellodendron amurense* Ruprecht. Its chemical analysis shows that this includes berberine, C<sub>20</sub>H<sub>19</sub>O<sub>5</sub>N, which has an insect repellent effect. The paper dyed with this yellow color was commonly used for Buddhist scriptures and government documents.

## **PAPERMAKING SCREENS**

It is not clear when bamboo screens were first used for papermaking in Korea, but it seems that bamboo and stems of pampas-grass or other native

grasses have been used as the main materials for papermaking screens for a long time. However, these days bamboo is mainly used. For making a screen only the outer layer of bamboo taken from between the nodes is used because the outer grain of bamboo is stronger and lasts longer. The split bamboo is carefully trimmed to make fine splints with an even thickness. Then the splints are bound together using fine thread on a weaving stand. Traditionally silk threads were twined and coated with persimmon juice, which makes silk threads strong and durable in water. Twined horse hair was also used for this purpose, but nowadays nylon threads substitute for them. In order to provide even strength during the making of a screen, small weights are tied to the end of each thread. The edges of a completed screen are wrapped with fabric.

There are three distinctive features of traditional Korean papermaking screens; one is that its length is longer than its width, and second the silk threads, which usually leave imprints as chain lines on paper, run along the length. The silk thread changes position in the middle of the screen moving over half a space. By doing this, the craftsman could avoid forming distinctive imprints on the paper from the silk threads that could weaken parts of a sheet. Normally Japanese and Chinese bamboo screens show some paired chain lines, which are more narrowly spaced than others. The length of bamboo splints is limited as only the parts of bamboo between the nodes are used. Therefore, in order to make the desired width of screen, often splints would be connected using silk threads. In Japanese and Chinese screens the joined ends of the splints appear alternately, and as a result both ends of the splints are bound with threads to secure the joined areas. However, a traditional Korean screen does not show these paired chain lines as the joined parts of two splints are usually scattered across the screen[6].

## **SCIENTIFIC ANALYSIS**

Traditional Korean papers have some distinctive characteristics due to the unique sheet formation and calendaring techniques that allow paper to have not only multi-grain directions and multi-layers but also a smooth, compact surface. Fifteen old Korean paper samples dated to the 14th century and the 18th century and five contemporary products were selected for close observation of their paper characteristics. Each sample was examined using a polarizing microscope and a scanning electron microscope (SEM).

A polarizing microscope enables clear observation of the morphological characteristics of the fibers by changing the angle of the analyzer. Analyzing fibers is one method to obtain important information on the materials used for each artifact, and this information can also be used as a reference to deduce the date when the paper was produced. The surface texture and

cross section of each sample were examined with the aid of SEM.

## **OBSERVATION**

Images from SEM show the distinctive features of traditional handmade Korean paper. The surface textures of eleven old paper samples present a densely packed and quite flattened surface. Most of them look as if sizing material was also applied during the traditional calendaring process. This feature is clearer when they are compared with images of contemporary paper samples. Some cross sections also revealed several layers, as if several thin sheets had been couched and pressed together to achieve a desired thickness.

Using a polarizing microscope, it is generally difficult to define the structural features of bast fibers as many features, such as the shape of fiber ends and the fiber width, may vary greatly even within a single fiber preparation. Moreover some immature cells may not show typical diagnostic features. However, some information was obtained through this analysis. The fiber in plate 5 shows well-defined and smooth cell walls with partial longitudinal splitting, which is characteristics of hemp.

## **CONCLUSION**

Since Korean adapted the papermaking skills, different types of handmade paper have been produced in Korea over time. However, the main features of traditional Korean paper can be defined as thick, strong, and warm white. These characteristics were due to several factors. First, the main material, paper mulberry has long fibers. Second, during the papermaking process fabrication was mainly done by cooking in natural alkali and beating, which cause less damage to the fibers. Third, traditional sheet formation enables paper to have multigrain directions. Fourth, traditional finishing process makes the paper surface smooth and compact. This might be the reason Korean papers were favored by the Chinese, who mainly produced fine and delicate paper that was not as strong as Korean paper. The Chinese also valued the smoother surface of Korean paper for use in calligraphy.

Korea played a vital role in the development of papermaking and in the transmission of papermaking skills to Japan. Knowledge of the techniques and materials used in traditional papermaking in Korea will help in understanding the history of papermaking in East Asia.

## Notes

1. Pan Chi-Hsing, *Chungguk jejigisulsa* [History of Chinese Papermaking Technology], translated from Chinese into Korean by Cho Bungmuk. Seoul: Sungchang, 2002.
2. Cho Hung-Kyun, *A Rresearch Report on Traditional Korean Papermaking*. Seoul: Korean Science Foundation, 1996. p 41.
3. Ibid., p 47.
4. Lee Sung-Cheul, *Urihanji* [Traditional Korean Paper]. Seoul: Hyeonamsa, 2002. p 82.
5. Cho, *A Research Report on Traditional Korean Papermaking*, p 45.
6. Barrett, Timothy, *Japanese Papermaking – Traditions, Tools, and Techniques*. New York: Weatherhill, 1983. Pan Chi-Hsing, *Chungguk jejigisulsa* [History of Chinese Papermaking Technology], translated from Chinese into Korean by Cho Bungmuk. Seoul: Sungchang, 2002.

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