SOME ISSUES ON THE PRESERVATION AND REINFORCEMENT OF PAPER-BASED RELICS

He Yuhong, Tianyi Ge Museum, Ning, China

ABSTRACT

Through a summary of the research on the preservation and reinforcement material and preservation technology of the paper-based relic, "Saddharma-Pundarika Sutra of the South Song Dynasty", which was unearthed from the Tianfeng Pagoda in 1982, this paper probes into the texture composition, material selection and preservation environment of the recovery process. Related factors in the process of preservation and administration are also explored.

KEYWORDS

Paper-based relic
Paper Preservation
Tianyi Ge Muesum
Library Documents' Preservation and Conservation

1. BACKGROUND

The "Saddharma-Pundarika Sutra of the South Song Dynasty" from the Tianfeng Pagoda, was un-earth by the Ningbo Cultural Relic Bureau in 1982. According to the research, this Sutra, which was a double-sided printed cultural relic, has a history of more than 1000 years. It was the first doubled-sided printed cultural relic discovered in China, and it is extremely valuable. It plays a great and significant role in China's paper-making and printing history.

The size of this Sutra is 21 cm. (L) x 7 cm. (W) x 3.8 cm. (H). It is bound in the shape of a forty-folded booklet. The cover of this Sutra is 0.296 mm. thick and the thickness of the tawny inner page is 0.087 mm. Appearance: it was attached a few ink on its surface and was seriously pulverized on its edges. The mechanical strength was zero, and it was illegible because of its serious aging. In China, we have different methods of protecting and restoring paper-based relics, including traditional mounting, silk-screen, membrane, Parylene vacuum membrane and resin reinforcement. For recovering this seriously damaged and pulverized Sutra, all of the above traditional methods can only achieve limited results. Therefore, we have to make a special multifunctional material to cure the pulverization.

Doing research on the materials for paper restoration has universal significance. As an ancient country with a history of 7,000 years, China abounds in paper-based

historical documents such as ancient books, paintings and calligraphy, scrolls, and rubbings from stone inscriptions. These cultural relics record the histories of politics, economics, cultural, military, religious, and social life in different historical periods. They are the most authentic and original documents reflecting the social life at that time, and they play an irreplaceable role in preservation of cultural heritage, in distributing human civilization, and in promoting social progress and social development. However, these paper-based cultural relics are fragile because they are easily affected by the natural and artificial factors during preservation and conservation work. Many of these precious paper-based cultural relics are becoming mildewy, and they are aging. According to the statistics, one-third of the extant ancient documents in China are in need of repair and restoration. Many well-preserved ancient books are aging as well, and the paper sheets are becoming yellow and fragile. Therefore, it is extremely urgent to solve these problems in the management of preservation and the conservation of these paper-based cultural relics. In these circumstances, we, the Ningbo Tianyi Ge Museum, the Nanjing Aeronautics and Astronautics University, and the Nanjing Museum jointly applied for a research project of "A New Reinforcement Material and Recovering Technology of the Sutra in South Song Dynasty" to the State Cultural Relic Bureau in 2001. This project tried to create a special glue for preservation of the "Sutra in South Song Dynasty" in accordance with its present situation, and it was approved and supported by the State Cultural Relic Bureau in 2002. This research project lasted for three years. Under the guidance of the relic preservation experts from the State Cultural Relics Bureau, the research group made an analysis of the composition of the Sutra paper, and consulted relevant documents and data. On the basis of many visits, investigation and study, the research group decided to use raw materials for experimentation. The natural high polymer materials, synthetic high polymer materials and nanometer materials were selected, purified, synthesized, modified and applied in the preservation and reinforcement work. This research project was checked and accepted by the State Cultural Relics Bureau in 2004.

2. TO ANALYZE AND RESEARCH THE SUTRA PAPER'S RAW MATERIAL STRUCTURE, THE ENVIRONMENT AND THE AGING MECHANISM

We performed analysis and research on the Sutra paper's raw material structure, the preservation environment and the aging mechanism. When the Sutra was unearthed, it was found wrapped in two layers. The outer one was a stone box, while the inner one was a wooden box. The Sutra was put in the wooden box. The whole package was buried under the ground of the Tianfeng Pagoda. Under such circumstances, the Sutra was in a relatively closed natural environment, and it was not much affected by the surrounding environment and climate conditions. Ac-

cording to the meteorological chronicles, the Ningbo area has been seriously hit by heavy climate changes about 600 times, changes such as drought or flood since the South Song Dynasty (1127 A.D.–). The great changes of temperature and humidity had affected the Sutra's surroundings. The Sutra aged gradually under this condition of the irregular changeable environment. The main reasons for the Sutra's aging include:

(1) The Sutra paper was affected by the temperature and humidity. The paper's fiber changed and became acidic. The condensation aldehyde bond of the cellulose molecule was sensitive to the acid. In the density of hydrogen ion, the glucoside bond split, the polymerization declined and the reduction increased. In this way, the paper's fiber became acidic and aged. The test showed that the Sutra was acidic.

(2) The germs and moulds in the Sutra bred encouraged by the changeable temperature and humidity in the Pagoda. Germs and moulds need oxygen, water and other nutrition in the air. Therefore, there are correlations of the PH value in the air. When the PH value in the air becomes acidic, this will affect and accelerate the aging of paper. These factors are coexistence but restrained by each other. Under the multi-functions of these factors, the paper cellulose became degraded. The germs live on the paper's fiber and permeated from the surface into the interior part and were dissolved at the contact point. The corrosion trace of saw-tooth marks was left on the surface of the cellulose. After the degradation of the cellulose by the microbe, the mechanical strength of the cellulose was greatly reduced until it lost all the strength. All these factors had functioned on the "auto-catalysis" to the aging and degradation of the paper fiber of the Sutra during the years.

The Sutra of the South Song Dynasty has been aging in the course of many years. Observed through a microscope, the fiber cells of the inner pages were seriously broken and most of the conduit molecules and thin-walled cells were cracked. There still remained some thin, long and complete fibers. Being tested, the paper pulp might be rice or wheat straw according to the fiber's structure and form.

3. TO SELECT THE PRESERVATION MATERIALS

For selection of the preservation materials, the research group had discussed and made experimentation on the basis of the present situation of the Sutra paper's aging mechanism. We have to insist on the principle of "Repairing the Old and Make It Like the Original One." On this basic principle, we made the following requirements for repairing and restoring this paper-base relic.

- To keep the original texture, thickness and color of this paper –base relic;
- To reinforce and preserve the aspects of fiber thickening, brittle reinforcing, pulverization curing, anti-fermenting and antisepsis etc.
- The requirements of the preservation material, like: transparent, colorless, non-luminous, non-filming, and excellent in imbibition, permeability and adhesion;

- To increase the property of tensile and endurable in folding strength;
- To not dissolve the handwriting and ink, non-fading, non-discoloring;
- It should have the property of being aging-resistant and prolong the degradation of the paper fiber;
- It must have the property of anti-bacterium and anti-silver-fish.

In order to keep the original appearance of the Sutra, which was damaged on account of various factors, synthetic materials with multi-functions were adopted instead of a single material.

The inner pages of the Sutra are a certain kind of plant fibers, like rice or wheat straw, which mainly consisted of cellulose, hemi cellulose, lignin, etc. It has a certain amount of hydroxides, which are connected by hydrogen bonds. It also has a few fruit acids and ash. The Sutra's paper is yellow, thick, and rough. The preservation material selected should be a natural material with long fiber, strong adhesive and fine permeability. According to the different priorities of the strengthening materials, we had done testing according to the requirements of the preservation of the paper-based relic. We concentrated on testing the synthetic polymer material, natural polymer material and nanometer material with specific functions. Through the experiments, four kinds of materials are selected.○,1 The polymer material of fluororesin, which is transparent, non-luminous and aging resistant; ○,2 The natural polymer material of deacetylated chitin, which has similar structure to the ancient paper fiber; ○,3 Oligomer active material with high reactivity, and ○,4 Bacterium nanometer material, which is mould proof. The synthetic polymer material features fine adhesion and strong curing. The natural material has a similar structure with the ancient paper fiber high in affinity and adhesion. The oligomer active material, with a low formula weight, is fine in imbibition and permeability. The nanometer material is effective in brittle fracture reinforcement, pulverization curing and mould resistance.

Then, the selected materials are modified. For example, the fluororesin is low in adhesion, permeability and salvation. Part of the fluororesins grafted by polar group, and was selected to take experimentation to improve their adhesion and permeability without changing their specific characteristics. The deacetylated chitin is hard to be dissolved, while it can easily be degraded though having similar chemical structure with paper fiber. In order to keep a certain adhesion with paper fiber, it is cross-linked and modified.

4. THE CHARACTERISTICS OF PAPER RESTORATION GLUE

There are three characteristics of this paper restoration glue:

(1) The combination of natural materials, synthetic high polymer materials and nanometer materials. The modified fluororesin which has the similar structure with paper fiber, and is fine in compatibility and affinity, deacetylated chitin,

both mold and bacterium resistant, and nanometer material, UV-ray and mold proof, which are adopted and combined together. The anti-aging problem is solved by fully utilizing the characteristics of these three kinds of materials.

(2) The paper-based relic can be reinforced and preserved through the methods of fiber thickening, pulverization curing, cross linking strengthening and bacterium resistance. Because of the adoption of the materials combined by low-molecular and polymer materials to the reinforcement, the preservation glue not only can permeate into the inner part of the fiber, but also can cover the surface of the fiber. Therefore, the preservation and reinforcement by stuffing, covering, permeating and thickening, can be handled both from the surface and the inner part of the paper fiber. It is a combination of physical reinforcement and chemical preservation.

(3) After strengthening the paper-based relic, which will not change its color, thickness and texture, it will effectively prevent it from becoming pulverized and corroded. It is an easy operation and effective. There is no change in the thickness and texture of the paper-based relics on the whole. The problems of luster, film-forming and color-fixing are solved.

5. CONCLUSION

Through the study of this project of "A New Reinforcement Material and Recovering Technology of the Sutra in South Song Dynasty," I emerged with some considerations on the issue of the preservation environment and conservation management of rare books and manuscripts. Paper aging is a process of gradual changes restricted by various kinds of environmental factors. So far, a large number of the ancient and rare books existent in China are aging. There are many factors, which make the paper age. Paper is affected by the preservation space, environmental temperature and humidity, external surroundings, light, dust in the air and UV-rays etc. At present, most of the libraries, museums and archives in China cannot provide a natural preservation environment with enough air circulation and constant temperature and humidity. The neglect of the management of the collection is another reason of the aging. Without enough air circulation and testing of the various factors which will harm the preservation environment, the books and manuscripts are going to age, and be infested with silver fish and mold.

Therefore, in order to prevent the aging of books and manuscripts and make them more durable, preservation of these books must be accomplished by chemical methods. However, it is more crucial to improve the daily management and control the whole process of the preservation environment by controlling and testing the surroundings, examining the temperature and humidity of the stack room along with the changes of the climate, and providing enough air circulation to build a more favorable preservation environment.

ABOUT THE AUTHOR

Ms. He Yuhong graduated from the archaeological Faculty of Zhongshan University, Guangzhou in July 1987. She has been working in the fields of archaeology, cultural relic preservation and museum work. Now, she is a deputy director and associate research librarian of the Tianyi Ge Museum of Ningbo City.