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Preface..... Satoru SATO

I : Scientific Perspectives on Paper

“Papyrography” : Scientific Analysis of Paper opens the New Aspect of CodicologyKazuyuki ENAMI

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Papyrography has its origin in French, a term of printing technique. It is a kind of lithograph using a paper plate instead of stone plate.

Metallography which is now accepted technical term for metallurgy, using the methods of analysing microstructure of metals and alloys by optical & electron microscopy and X-ray analysis. The term metallography once was also used for the printing technique of lithography by metal plate instead of stone plate.

Analogically, we here propose to adopt “Papyrography” as a new technical term for analysing the morphology and microstructure of paper using methods shown below.

1. Observation of overall and microscopic morphology of paper by High-Resolution Digital Microscopy.
2. Detection and identification of remains of plants, insects, cloth, thread, ink, etc on/in the paper.
3. Measurement of laid line pattern remained on paper; numbers /unit, and distribution, using Mathematical soft wear (Fast Fourier Transformation analysis) developed by Ryukoku University.
4. Analysis of elements on/in the surface of paper, ink, pigments by X-ray Fluorescent Analysis.

“Handmade Washi Paper: From Kozo Production to Paper”—Revealed to this extent with a digital microscope.....Shigeru SAWAYAMA

In 2014, four types of traditional Japanese papermaking techniques, known as “Washi:

handmade Japanese paper”, were registered by UNESCO. These are Echizen Washi, Hon-Mino Washi, Sekishu Washi, and Hosokawa Washi. These papers are prepared by traditional handmade techniques and are highly valued for their quality and texture. By being registered as intangible cultural heritage by UNESCO, these traditional techniques will be preserved to future generations.

In this paper, we observed the microstructure of handmade washi samples made by traditional methods using a high-performance digital microscope with an optical non-destructive method. We clarified the samples used and the measurement conditions to deepen the understanding of the materials and techniques used in washi production and to enable the reproducibility of the experiments even for non-specialist users of the measuring instruments. We showed an example of the possibility of “visualizing” and “quantifying” the morphology of washi.

Measurement of Surface Roughness of Washi Paper Using a Digital Microscope and Its AccuracyAsuka YAMATO

Many digital microscopes in recent years have the ability to automatically focus on an object of varying height by depth compositing to obtain an image with all parts in focus, as well as to record three-dimensional image information in 3D. Various measurements such as length (distance), volume, and surface roughness of arbitrary points can be easily performed. However, despite its ease of use, depth composite methods require the selection of various measurement conditions such as magnification, light source, and depth composite measurement pitch, and the accuracy of the information obtained is expected to differ for each of these conditions. In this paper, we focus on the surface roughness measurement function of the digital microscope and report the results of our verification of appropriate measurement conditions for roughness measurement using roughness standard specimens.

II : Non-destructive analysis reveals art and classic books

Precise Microscopic Analysis of Japanese Torinoko Paper used for Rembrandt Copper Prints of The State Hermitage Collection

.....Kazuyuki ENAMI, Yoshihiro OKADA, Elena SHISHKOVA, Roman GRIGORYEV

It is well known among paper historians in Japan that Rembrandt used Japanese Torinoko paper (Gampi paper) for his Copper prints. While no concrete results by Scientific analysis of paper of those Copper prints directly had not been shown until our study “Encounter of Japanese paper with Europeans. From Portuguese Jesuit Missionary to Rembrandt”, “ENAMI Kazuyuki, SAKAMOTO Shoji, OKADA Yoshihiro, TOYOSHIMA Masayuki, ISHIZUKA Harumichi, Elena SHISHKOVA, Roman GRIGORYEV, IPH 2014 Congress Book, 2017, vol.20, pp. 111-123”,.

In that study we analyzed the paper used for ten works of Rembrandt of the Rovinsky Collection of the State Hermitage, using high resolution Keyence digital microscope.

It was found that Rembrandt really used Japanese Torinoko (Gampi) paper for his ten Copper prints, at least. Here we show the results in the first time in Japanese for Japanese paper researchers.

A Transdisciplinary Study of *Da Qing Shengzu Ren (Kangxi) huang di shi lu: Examining History by Paper Non-Destructive Analysis* XU Xiaojie

Kangxi huang di shi lu (康熙帝實錄) was edited from 1723 and completed in 1731. The *Kangxi huang di shi lu* in the Toyo-Bunko collection is volumes 151-300 of the total of 300 volumes. There are two versions of the manuscripts in the collection: Da Hongling Ben 大紅綾本(“the large red damask book”) which was stored in the Capital Archive (Huangshicheng 皇史宬); and the Ziling Ben 紫綾本(“the purple damask book”), which had been mended after 1901, at the end of the Qing dynasty.

The paper used for Da Hongling Ben and Ziling Ben has been described as “Jingxian Bangzhi 涇縣榜紙”(Top quality Xuan paper), but there is a suspicion that the type of paper used may be different. In order to clarify this question, due to the limitation of research based solely on historical records, I used the Keyence VHX-7000 ultra-high precision digital microscope to observe the surface of the paper, which allowed us to safely examine the raw materials used in the paper of the manuscripts.

By the non-destructive method of examining the paper quality, we were able to clarify the appearance of the “Jingxian Bangzhi” as recorded in the literature. In addition, by going beyond the limits of the textual information, and through non-destructive method, the paper differences between the Da Hongling Ben and Ziling Ben were identified. The historical background that gave rise to these differences was made more visible through the microscopic world of paper quality and visual images. As described above, reconsidering history from the two angles of “text” and “objects” through the method of “the fusion of literature and science” is extremely important for the new development of historical research.

Scientific Study of paper used for Ukiyoe Pictures published in the Edo-era by High-resolution Digital Microscope

..... Kazuyuki ENAMI, Yoshihiro OKADA, Satoru SATO

Ukiyoe is world collectors’ item today, but the price of an Ukiyoe picture in Edo era was very cheap only 480~720 JPYen equivalent in today’s price level. It has been generally believed that pure Kozo (Broussonetia kazinoki) paper “Hosho” (thick and sized by alum) had been used for Ukiyoe printing, until now. However, to use higher price (400 JPYen or more/sheet; as above) “Hosho” paper was absurd. In addition, Ukiyoe was really Pop arts for ordinary citizens and from the beginning of full colour Ukiyoe publishing Nishikie originated by

Harunobu in the first time in 1764 to 1880s, over 200 million sheets had been printed and gave citizens pleasure to touch full colour Pop arts. To prepare such tremendous amount of “Hosho” paper, or Nishinouchi Kozo paper and Iyo Kozo paper for not high quality Ukiyoe was really impossible.

To give the answer to the question “What kind of paper was for Ukiyoe used really?” is the main purpose of the present study. We studied that paper used for around 100 works of Ukiyoe published during 1680s to 1880s of artists, including Picture books, printed by Sumizuri (B&W) of originators of Ukiyoe art, HISHIKAWA Moronobu, NISHIKAWA Sukenobu, SUZUKI Harunobu, and Nishikie (full colour Ukiyoe:Nishikie) artists :KATSUKAWA Shunko, Utamaro, Hokusai, Toyokuni 1st, Hiroshige, Kunisada(Toyokuni 3rd), Kuniyoshi, Kiyochika, and others (all private collection of an author E.K.) were analysed using digital microscope Keyence VHX-5000. It was found that paper used for all works analysed in the present study was mixed paper made from Kozo and Mitsumata (*Edogeworthia papyrifera*) or rice straw fibres, filled with rich amount of rice powder (not glue). Hereafter, we will show our quite new results on paper used for Ukiyoe.

Classical Literature, Arts and Advanced Technology

.....Taketoshi HIBIYA, Shigeru SAWAYAMA, Asuka YAMATO
Rice starch granules had been historically recognized as sizing materials for Japanese *washi*, so that high quality of writing and printing were assured. Conventionally a rice starch granule on paper surface had been detected by observing its shape and size using a microscope. The authors identified successfully an extinction cross of rice starch granules by polarizing microscopy with the crossed Nicol condition using epi-illumination. An extinction cross can be observed in a rice starch granule, because it shows a spherulite structure with optically uniaxial symmetry. This crystallographic structure is accompanied with birefringence. Using a sensitive color board, rice starch granules are easily identified. The effect of background color on visibility for an extinction cross was discussed on a paper surface. In comparison to light color of background, dark color background can suppress scattering of polarizing light and results in better visibility. In recent years basic data of colorants used for woodblock prints has been prepared and fulfilled. This would enhance scientific research on woodblock prints.

III : Japanese Literature Research by Non-destructive Analysis

Challenges in Identifying Fragments as Origination from the Same Manuscript and How to Address Them: Methodology for Paper Analysis Using High-Definition Digital Microscope Kazuya FUNAMI
The primary issues and corresponding measures to address them are outlined in three main points.

1,Problems Arising in Identifying Raw Materials Based on the Width of Plant Fibers and Their Solutions:

Conventional data on plant fiber widths often exhibit significant variations among different measurers. To address this issue, it becomes imperative to individually measure the fiber width of each plant using modern Japanese paper as a standard sample and establish a basic ledger as a reference. Additionally, we recommend incorporating the length of plant fibers as a supplementary criterion for identifying raw materials, following the methods employed in paleography. As a precondition, it is essential to acknowledge the difficulty in identifying raw materials solely based on the width of plant fibers.

2,Challenges Arising from the Coexistence of Multiple Types of Plant Fibers and Plant Skin in the Same Paper, and Their Resolution:

When identifying and asserting the presence of plant fibers from different species than the primary plant fibers that constitute the paper, it is crucial to provide a detailed explanation supporting such a conclusion in written form. Furthermore, including a comparative image will aid others in understanding the differentiation. Additionally, it is essential to clarify whether the inclusion of plant fibers from different species was intentional or accidental during the papermaking process. Since the method of distinction is not yet established, its development becomes necessary. Moreover, if the presence of elements such as plant epidermis, besides plant fibers, is identified and one seeks to attribute it to the primary plant fibers forming the paper, it is imperative to explain and provide a representative sample image of the epidermis for others' observation.

3,Accurately Describing the Shape of Plant Fibers:

The shape of plant fibers varies between different varieties. Utilizing 2D images and text alone may not be sufficient to effectively communicate the characteristics of plant fibers to others. To provide a comprehensive explanation of the plant fiber shape, it is recommended to include data such as 3D images of plant fibers and cross-sectional views of paper.

A Study of ‘MABOROSHI’ of *The Tale of Genji*, said to have been written by Fujiwara no Tameie—Research through paper quality investigation using high-definition digital microscope, high-resolution scanner, and X-ray fluorescence analyzer Takashi YOKOI, Shigeru SAWAYAMA, Taketoshi HIBIYA
The manuscript of *The Tale of Genji*, said to have been written by Fujiwara no Tameie (1198-1275), is an old and important manuscript dating back to the middle of the Kamakura period. However, only one volume retains its original form; all the others have been renovated and have been reduced to fragments. The restoration of the Tameie version is an important task for the study of *The Tale of Genji*.

Currently, manuscripts and fragments that can be confused with the Tameie manuscript are intricate, and it is difficult to determine which is the genuine manuscript using conventional research methods.

In this article, we will verify whether the newly released material (the scroll 'MABOROSHI' owned by Jissen Women's University) is the genuine Tameie version. We attempted to use high-definition digital microscopes, high-definition scanners, and X-ray fluorescence analyzer, as a method to guarantee objectivity and reproducibility for verification. The process of that analysis is reported here.

Myoyu, Uchigami, and the Myoyu version of The Tale of Genji, etc. Eiko UENO

Among the many manuscripts of the Tale of Genji, the "Myoyu-bon" is considered to be the second most important text after the "Fujiwara Teika's handwritten manuscript."

In this article (1), I will first introduce the person named Myoyu, who compiled the Myoyu-bon, and that he was a descendant of Fujiwara Teika and was from the Reizei family, which specialized in waka poetry. He was active during the Sengoku-period. He was a monk of the "Jishu-Group", which was all the rage at the time. And he taught waka and classical works to Jishu's followers as a poetry expert.

In (2), the Myoyu-bon includes a volume that imitates "Fujiwara Teika's autograph" and a volume (eight chapters) that imitates Teika's handwriting. I will discuss that the method of copying Teika's handwriting was often practiced by Myoyu's father, Tamekazu Reizei, and that the Myoyu version was likely influenced by this method.

Regarding (3), I will discuss the paper manufacturing technology at the time when the Myoyu-bon was formed, especially the Uchigami technology. As paper-making methods had progressed, Uchigami was no longer an essential task. However, I also mentioned that in the case of high-quality paper, Uchigami was sometimes requested as a special order, and that there were various cases in which Uchigami could be easily done at home.

In (4), I introduced the results of observing Myoyu-bon using a high-definition digital microscope, along with images. I also reported that some had been beautifully Uchigami-paper, while others had no process at all, and that there were a variety of plants used as raw materials for paper. In the case of The Tale of Genji, it is normal to use the same paper, but in the case of Myoyu-bon, it seems that a large quantity of paper of the same quality was not available. I suggested that Myoyu may have created the Myoyu-bon using paper donated by Jishu's followers.

Editorial postscript Takashi YOKOI