

Study on the techniques of wallpaper (“Biaohu”) in the Palace Museum: Case on Lodge of Bamboo Fragrance(Zhu Xiangguan)

Ma Yue (✉ mayue_cc@hotmail.com)

Palace Museum

Congshan Zhao

Ministry of Culture and Tourism

Yong Lei

Palace Museum

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Study on the techniques of wallpaper (“*Biaohu*”) in the Palace

Museum: Case on Lodge of Bamboo Fragrance(*Zhu Xiangguan*)

MaYue^{12*}, Zhao Congshan³, Lei Yong¹²

Abstract: “*Biao Hu*” was one of the eight famous traditional crafts in the late Qing dynasty. Its function was decorating the interior of ancient buildings and making burial objects, including ceilings, walls and windows. It was popular in the buildings of northern China in the early Qing dynasty. There were white and patterned wallpaper in the Forbidden City, the latter included traditional and rare patterns in the Palace. Take the wallpaper in Lodge of Bamboo Fragrance(*Zhuxiang Guan*) as an example, in this article, its structure and composition are studied by morphological observation and spectral analysis. Combined with the analysis of the patterned wallpaper in other buildings of the Forbidden City, the traditional technology is studied.

Key words: the Palace Museum, pattern, wallpaper

1 Background

The traditional crafts in ancient China named “*Ying Zao*.” “*Biao Hu*” was one of the eight crafts in late Qing dynasty. They were composed of tile, wood, stone, scaffold, soil, paint, colored painting and wallpaper. The use of paper and textile on the ceiling, wall and window was popular in the buildings of northern China in the early Qing dynasty. There were many records of it in the historical archives of Ming and Qing dynasties, which is related to the climate and building type in northern China. The wallpaper helps to prevent cold and dust, adjust the relative humidity, improve the illuminance, etc. There are a large number of wallpaper remains in the Forbidden City building, among which there are various decorations on it, most of which are green dragon with “ 卐 ” characters, as well as twigs and lotus, “prolonging

*Correspondence: mayue_cc@hotmail.com

1 Department of Conservation Science and Technology, The Palace Museum, 4 Jingshan Qianjie, Beijing 100009

2 Key Laboratory of Calligraphy and Paintings Conservation, Ministry of Culture and Tourism, Beijing, China

3 Department of Architectural Heritage, The Palace Museum, 4 Jingshan Qianjie, Beijing 100009

life" patterns,etc. On the roof of the second floor of the south ear room in *Zhu Xiangguan*, rose flower decoration was found, which was rare in the Palace Museum.

Zhu Xiangguan is located in the northwest corner of the fourth courtyard in the Qianlong Garden, it was built in the 37th year of Qianlong period of Qing dynasty, in imitation of the *Bilin* Pavilion of the Palace of Established Happiness (*Jianfu* Palace).It is divided into two floors, connected with *Juan qinzhai* and *Yu cuixuan*.The patterned wallpaper was found on the ceiling of the second floor during the conservation work, it has been taken off as a whole under conservation.

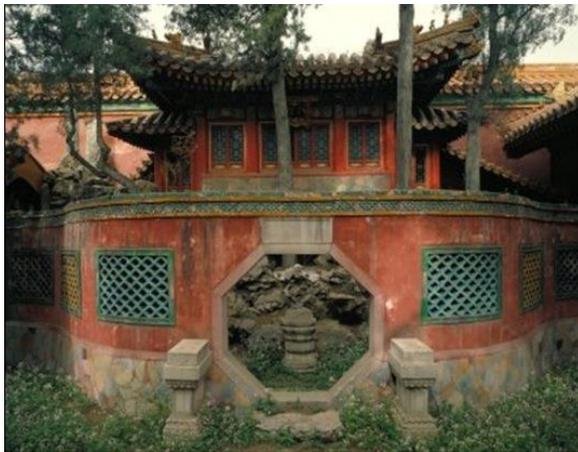


Fig.1 Exterior of *Zhu xiangguan*

Fig.2 patterned wallpaper in *Zhu xiangguan*



Fig.3 Sample of patterned wallpaper in *Zhu xiangguan*

The wallpaper appeared yellowing, cracking, missing and other diseases under environment. It can be divided into six layers, the pattern of the outermost layer is rose, the other layers are twigs. The structure and composition of the wallpaper were studied by microscopic observation and spectral analysis.

2 Scientific Analysis

The sample is taken from edge of the wallpaper. It is embedded with Technovite 2000LC resin (Henraeus Kulzer Co.), polished after curing under ultraviolet light for 30 minutes. Observed under visible and ultraviolet light(Leica 4000M),it can be divided to five layers at least.



Fig.4 Microstructure of crosssection

Vis, 100X



Fig.5 Microstructure of crosssection

UV, 100X

The structure of pigment and fiber were observed by microscope. As an example, on the surface of the fifth layer (the outermost layer) and the second layer, the pigment and paper fiber are different, so component analysis is required.



Fig.6 Microscopic morphology of the 5th layer
20X

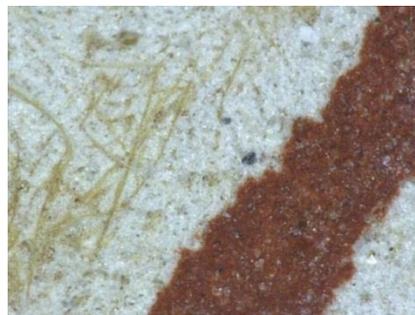


Fig.7 Microscopic morphology of the 5th layer
150X



Fig.8 Microscopic morphology of the 2nd layer
20X



Fig.9 Microscopic morphology of the 2nd layer
150X

Micro-XRF imaging analysis was taken on surface of the patterned wallpaper. From the distribution of element, it shows that the red vein lines of flowers mainly contain Ba, brown yellow leaves and mainly contain Cr,. The white part of the flower is rich in Ca. The distribution of Fe reflects the red pattern on the surface of layer1-4. The specific components of each part of the material need to be further analyzed.



Fig.10 the 5th layer of patterned wallpaper

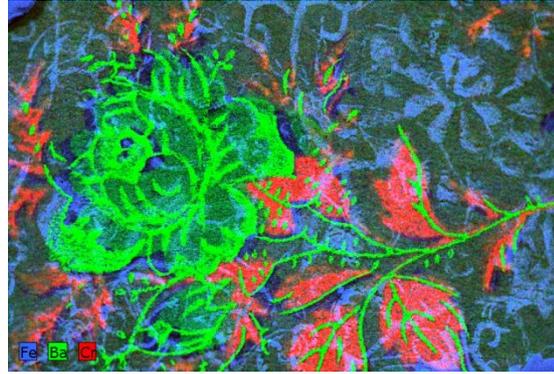


Fig.11 Mapping of Fe/Ba/Cr

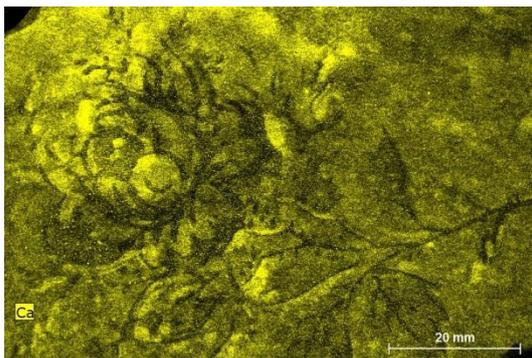


Fig.12 Mapping of Ca

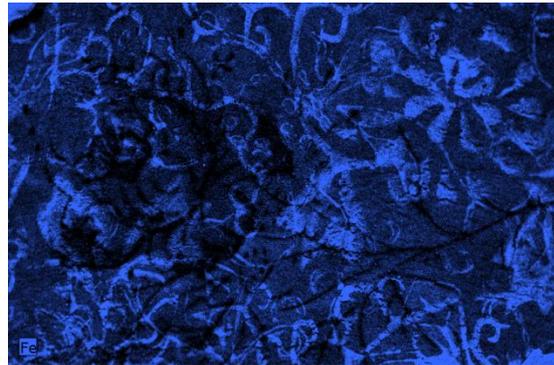


Fig.13 Mapping of Fe

The distribution of elements of the fourth layer was analyzed, Fe is mainly existed in the red pigment.



Fig.14 the 4th layer of patterned wallpaper

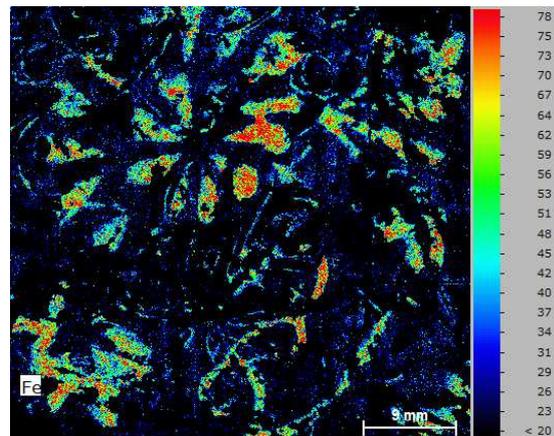


Fig.15 Mapping of Fe

Red and brown sample from the fifth layer were observed by polarized microscope (Leica,4500P). Organic dyes may be used in the red vein. A small amount

of red sample were taken by ultra-high performance liquid chromatography-time-of-flight mass spectrometry (Waters UPLC H-class) and Waters G2-XS QTOF MS. After 10 min, was extracted by ultrasound at 70 °C with 0.1 mL DMSO, centrifuge, remove the clear liquid and set aside, the residue in 0.1mL MeOH/H₂O/HCl (1: 1, V ≤ V) at 70 °C. was extracted by ultrasonic at 70 °C for 10 min, and then concentrated and redissolved with clear liquid of first step, then to be measured

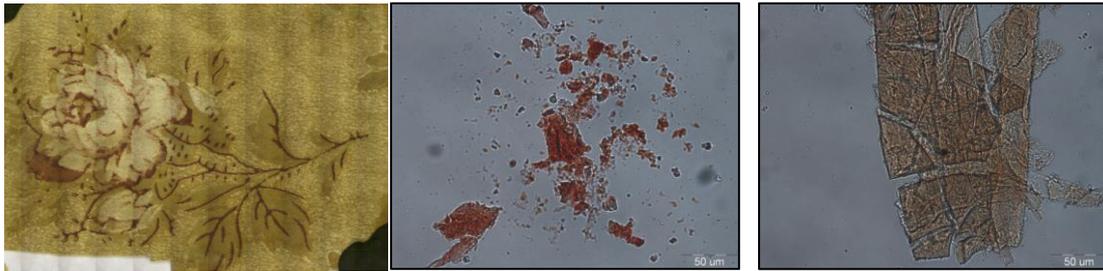


Fig.16 Microscopic morphology of red dye(Single polarization)

Fig.17 Microscopic morphology of brown dye(Single polarization)

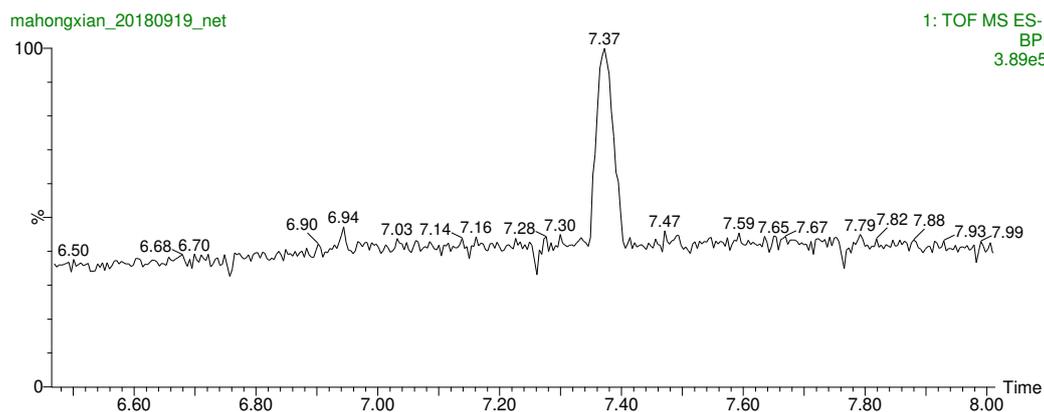


Fig.18 Chromatogram of the red dye(UPLC-QTOF-MS ESI)

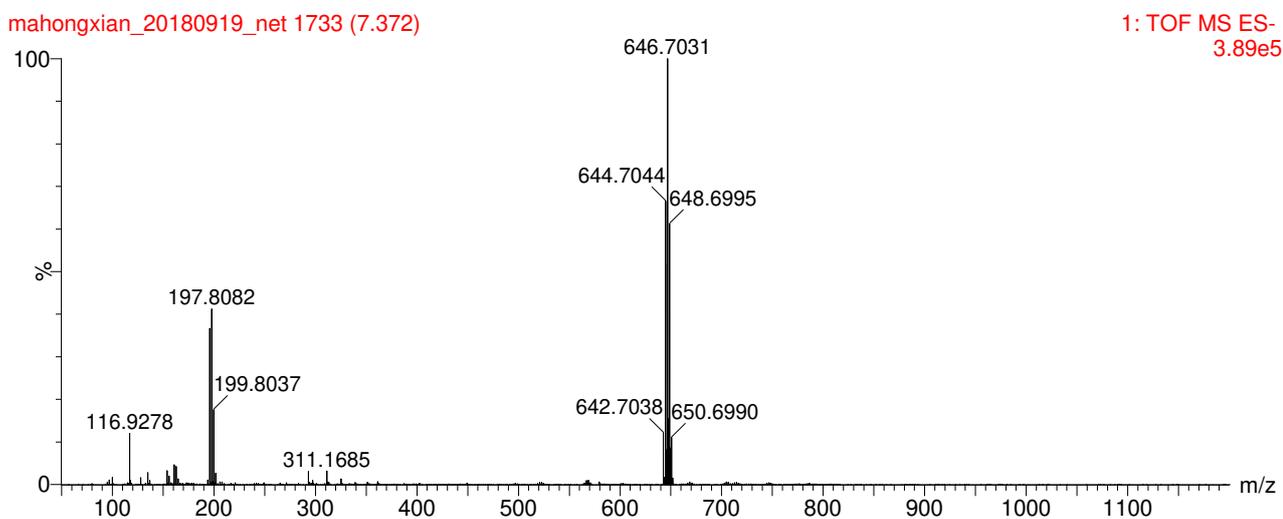


Fig.19 Mass spectrum at 37min

Table 1 Compound analysis

样品编号	保留时间 /min	母离子 m/z (-)	化合物
红色勾线样品	7.37	646.703	酸性红 87 (曙红)

According to the analysis by Ultra High Performance Liquid Chromatography-Mass Spectrometry ,the red vein may have used a synthetic dye, which is relatively rare on the wallpaper in the Palace Museum, which may be of the later communication or renovation between China and the West. This requires further discussion.

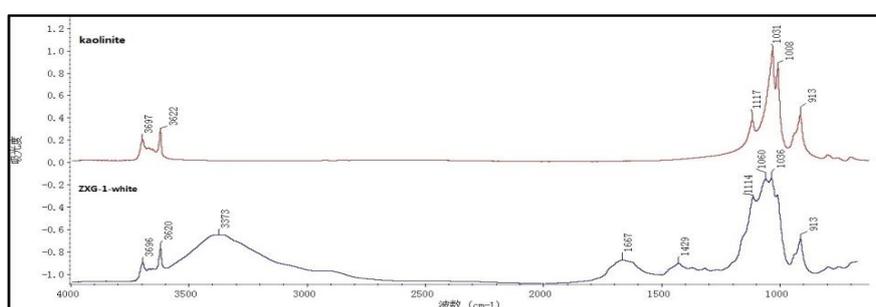


Fig.20 Micro-FTIR spectrum of white pigment the 5th layer

The main component of the white part of the flower is the kaolinite group mineral and the lime.

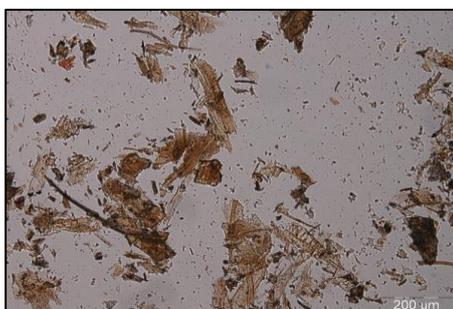


Fig.21 Microscopic morphology of the 5th layer (Single polarization)



Fig.22 Microscopic morphology of the 5th layer (Orthogonal polarization)



Fig.23 Microscopic morphology of the 5th layer (transmitted light, pit of wood cell)



Fig.24 Microscopic morphology of the 5th layer (transmitted light, wood ray)

Paper fiber of the fifth layer was observed under polarized and transmission microscope. The shape of sawdust under polarized light, the hole and wood ray structure under transmission light all proved it to be wood fiber. Maybe this layer was pasted later from the 1-4 layers.

Decoration on the 1-4 layers are traditional types in Qing dynasty. From the red pigment and microstructure of paper fiber analysis, the red pigment may be iron red, and the white bottom ash contains talc, the paper mainly contains bamboo fiber. It is similar as other buildings studied by the author. It all shows that traditional materials and technique were used in 1-4 layers. Because the surface of the third layer is seriously wore, and the pigments on the 1-3 layer is more orange, so it is speculated that the 1-3 layers were pasted together, and the fourth layer was pasted later. So the 1-6 layers of wallpaper has been pasted at least 3 times.



Fig.25 the 4th layer of patterned wallpaper



Fig.26 the 3th layer of patterned wallpaper

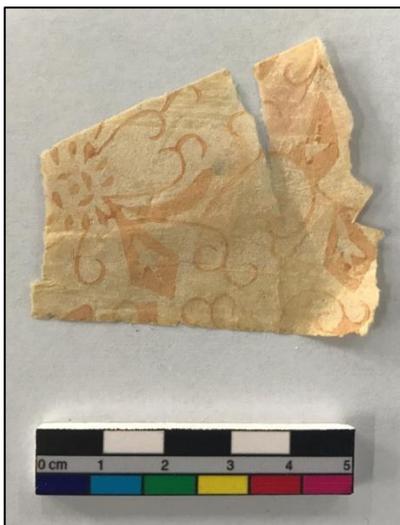


Fig.27 the 2nd layer of patterned wallpaper



Fig.28 the 1th layer of patterned wallpaper

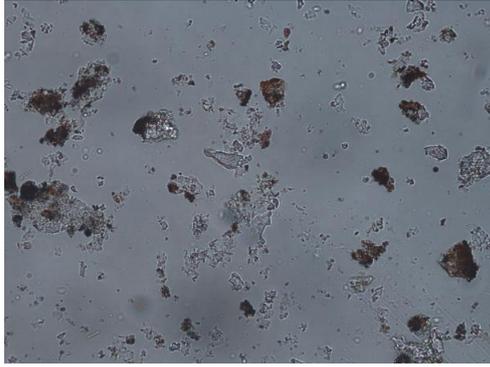


Fig.29 Microscopic morphology of the red dye on the 4th layer (Single polarization)



Fig.30 Microscopic morphology of the red dye on the 4th layer (Orthogonal polarization)

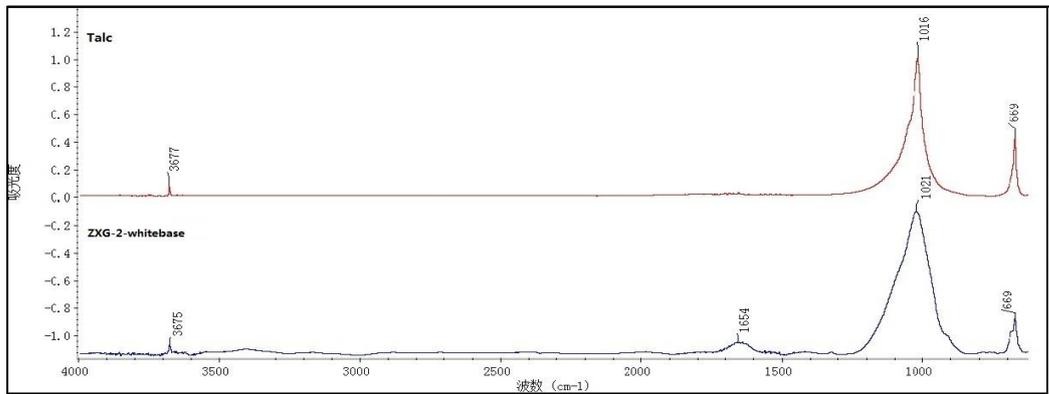


Fig.31 Micro-FTIR spectrum of white pigment the 4th layer



Fig.32 Microscopic morphology of the 4th layer (Single polarization)

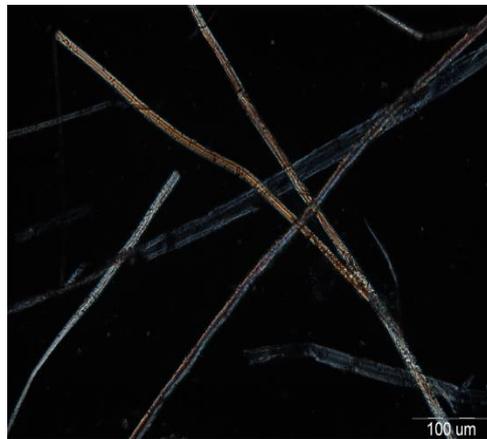


Fig.33 Microscopic morphology of the 4th layer (Orthogonal polarization)

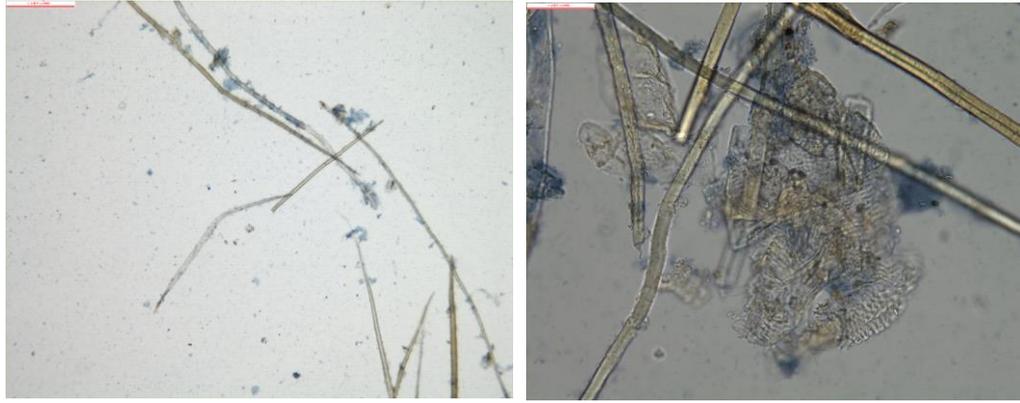


Fig.34 Microscopic morphology of the 4th layer (transmitted light, pit of wood cell) Fig.35 Microscopic morphology of the 4th layer (transmitted light, wood vessel)

3 Wallpaper in the Hall of Mental Cultivation(*Yangxin Dian*)

During investigation of the wallpaper in *Yangxin Dian*, many types of patterned wallpaper was found. The following are examples compared with it in *Zhu Xiangguan*, traditional decoration and the one using synthetic pigment are discussed.

3.1 Wallpaper with dragon and “卍” patterned decoration

The residue of patterned wallpaper was found on the backing wall in the Hall of Following the Practice(*Tishun tang*), it is decorated with traditional dragon and “卍”. The distribution of surface elements, green pigment and paper fiber are analyzed. The results show that atacamite, lime, talc for white base and bamboo paper were used. They are all typical traditional materials in the Qing dynasty.



Fig.36 patterned wallpaper on the west room of *Ti shuntang* in Hall of Mental Cultivation (*Yangxin dian*)

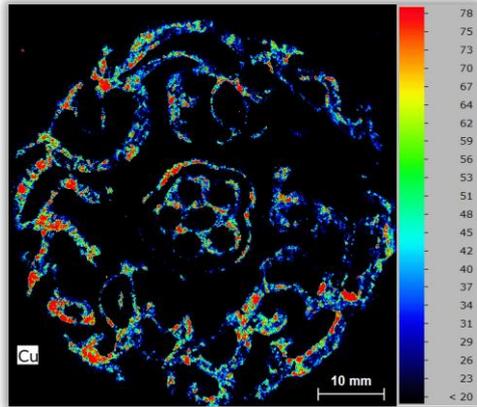


Fig.37 Mapping of Cu



Fig.38 Mapping of Cu/Si/K

3.2 Patterned wallpaper on the wall surrounding the bed (*Kang*) in the western buildings of *Yangxin Dian*

The wallpaper on the wall surrounding the bed (*Kang*) is quite different from others, the pigment and technique were analyzed.



Fig.39 patterned wallpaper on surrounding of the bed in Hall of Mental Cultivation (*Yangxin dian*)

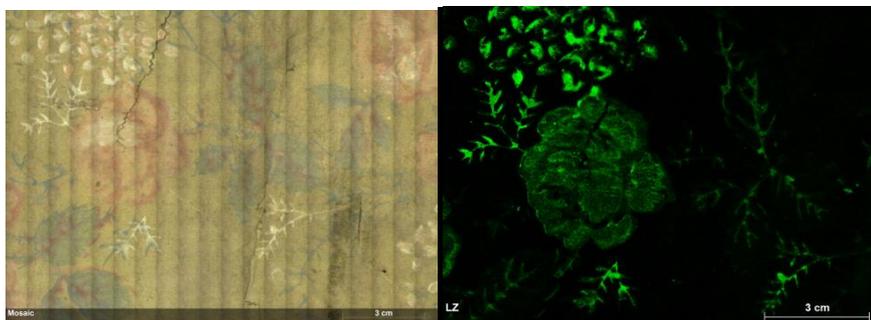


Fig.40 Mapping of Ba

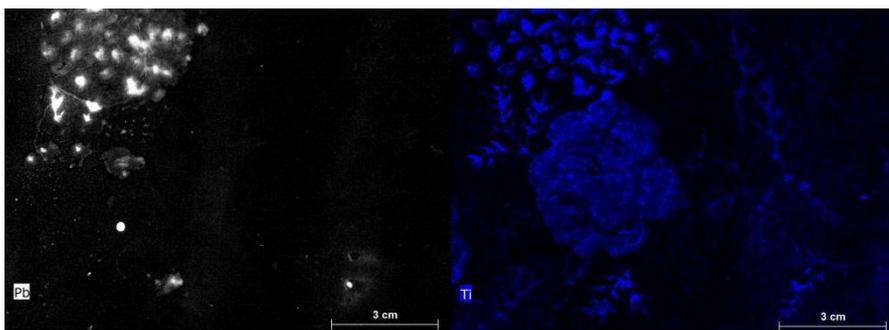


Fig.41 Mapping of Pb

Fig.42 Mapping of Ti

The white pigments includes Pb, Ba and Ti, so titanium white and barium white. It also proves that this wallpaper was pasted later, and the time can be further discussed with the dye analysis.

4 Discussion

In the study of wallpaper in the Palace Museum, there are many kinds of patterned ones, but it most common in Qing Dynasty are traditional decoration, such as green dragon, twigs and lotus, curly grass and so on. However, in the investigation of several patterned wallpaper in *Zhuxiang Guan* and *Yangxin Dian*, we found that some of the outermost layer used modern synthetic dye or pigment, and the paper was also with wood pulp. The surface of these wallpaper were richly decorated, which is different from the traditional style of Qing Dynasty. According to the comparison with western wallpaper, they are similar in decoration. These wallpaper may be related to the communication between China and the West, and the times and techniques between them will be studied in conjunction with the literature in the future.

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Availability of data and materials The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations Competing interests The authors declare that they have no competing interests.

Author details

1 Department of Conservation Science and Technology, The Palace Museum, 4 Jingshan Qianjie, Beijing 100009, China.

2 Key Laboratory of Calligraphy and Paintings Conservation, Ministry of Culture and Tourism, Beijing, China

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