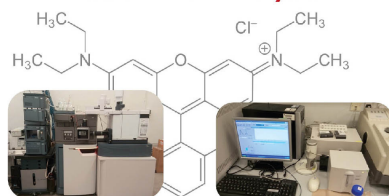


# Analysis of Synthetic Dyes and the Treatment of 1910's - 1950's Historic Chinese Wedding Documents

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## Scientific Analysis



Ultra-performance liquid chromatography  
Electrospray ionization mass spectrometry

UV-Vis spectrometry

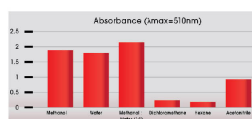


## 2. Scientific Analysis

### Extraction of Dyes

The selection of solvents is of vital importance for the analysis of synthetic dyes. Notably, most of the dyes are polar organic compounds, which are highly soluble in polar protic solvents like methanol and water. Methanol was used for extraction of the sample dyes (Scheme 1 & 2). Other parameters affecting the extraction efficiency include sonication time, volume of solvent and sample sizes were also evaluated by the UV-Vis spectrometer (absorbance maximum of red dyes is from 450nm to 560nm). The extraction method can be selected by comparing their absorbance values of different methods.

**Scheme 1** Optimization of extraction method by screening of solvents



**Scheme 2** UV-Vis Spectrum of Extracts Using Different Extraction Solvents



### Structural Identification of Dyes

Ultra-performance liquid chromatography with both diode array UV-Vis detector and time-of-flight mass spectrometer (Reverse phase UPLC-DAD-ESI-Q-TOF-MS or UPLC-MS) have been employed for structural identification of dyes. It is a technique for the separation and identification of organic compounds from complex mixtures (i.e. the sample extracts). It is ideal for providing chemical information of trace amount of compounds extracted from paper samples. In this work, eleven (# 1-11) synthetic dyes have been identified from the documents dated from 1910 to 1950's. Given most of them are single and double azo dyes, which are all water sensitive, we therefore considered to employ a dry lining Chinese mounting for treatment of this type of wedding documents.

**Scheme 3** Characteristic of Dyes Identified on the Wedding Documents

Objects	Identified Dyes	Type of Dye	Water Sensitivity
1910's	#1	Single Azo	**
	#4	Single Azo	****
1950's	#1	Single Azo	**
	#9	Xanthene	*
	#10	Xanthene	**

**Table 1** Eleven Dyes Identified on the Wedding Documents

#	Structure	λmax (nm)	Molecular ion peak (m/z)	Structure	λmax (nm)	Molecular ion peak (m/z)	Structure	λmax (nm)	Molecular ion peak (m/z)		
1		486	327.0443 (M-Na) <sup>-</sup>	5		515	511.0362 (M-2Na+H) <sup>-</sup>	8		381	198.1027 (M+H) <sup>+</sup>
2		510	536.9712 (M-3Na+2H) <sup>-</sup>	6		503	511.0362 (M-2Na+H) <sup>-</sup>	9		557	443.2529 (M+H) <sup>+</sup>
3		506	435.0350 (M-2Na+H) <sup>-</sup>	7		520	539.0684 (M-2Na+H) <sup>-</sup>	10		543	415.2020 (M+H) <sup>+</sup>
4		508	457.0151 (M-2Na+H) <sup>-</sup>				11		529	648.7149 (M+H) <sup>+</sup>	



## 1. Introduction

Cultural property is a unique testimony to the culture and life of a community. "Three Covenants and Six Rites" is one of the exquisite items validating stories in the several thousand-year long Chinese History. "Three covenants" were formal wedding documents exchanged between two families to commit a marriage. They were parts of the core and essential records of a newly formed Chinese family. Yet, the documents have always been abandoned or misplaced without proper care after the completion of wedding rituals. Therefore, most of the items have suffered from various degrees of damages. Our team conducted scientific analysis of the unique red dyes used on wedding documents and undertook remedial conservation treatment for them. These wedding documents are the collection of Hong Kong Museum of History from 1910s to 1950s and from the Pearl River Delta region of China.

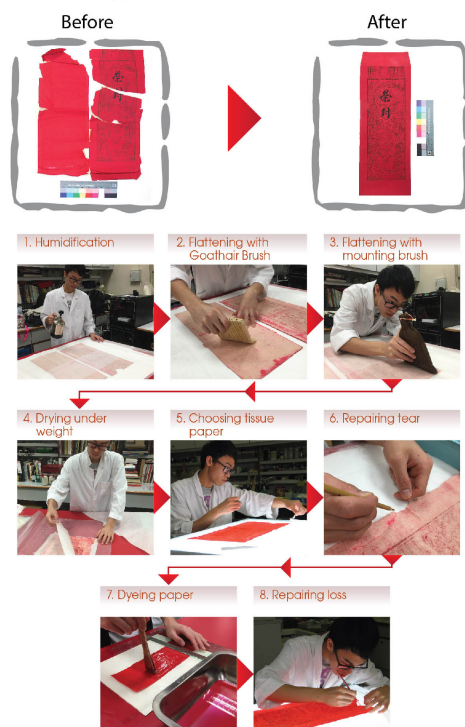


## Mounting Tools



## 3. Treatment

In view of the fugitivity of the red dyes reported above, any wet treatments are not recommended. Instead, the Chinese traditional lining technique together with Japanese materials worked well and eased the problem arisen from treatment. Moisture from the watery wheat starch paste put on the water-cut Japanese paper strips could be significantly reduced by laying a strong absorbent paper underneath after the application of paste at the front. This is the dry lining technique widely used in the East. Despite the very thin and weak paste, there is still sufficient adhesion to hold the repaired papers and the document together effectively by the specific lining and the smoothing actions of the Chinese palm brush developed in the course of application.



## Conclusion

In conclusion, eleven synthetic dyes have been identified, which indicated that synthetic dyes (both single and double azo dyes) have been commonly used during 1910's to 1950's in southern part of China. In view of the water sensitivity of the azo dyes, conservators may consider to use Chinese dry lining technique.

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