Reconstruction of the Historical Golden Pigment Making Process Based on BnF Ms. Fr. 640

Background

Defining Terms

- Nowadays, Many people want to reconstruct the historical pigment, within the subsection of the reconstruction of historical pigments we have two further subdivisions:
  - **Market "historical" pigments:** Colors where scientists used organic chemicals to **mimic** the characteristics of historical pigment.
  - **Manuscript-based historical pigments:** Colors made by following the exact historical manuscript, usually made out of plants and minerals

Market "Historical" Pigment vs. Manuscript Historical Pigment

- We can only mimic what we know.
- It is not clear if these market-made pigments actually recreate the true character of the ancient pigment

Challenges of Reconstructing a Pigment Based on a Manuscript

More like a set of working notes
Conditions change
Make a living rely on the manuscript

Figure 1. Segment of Original BnF Ms. Fr. 640 Manuscript

Problem & Hypothesis

Problem

- Why for some paintings the modern replica looks different from the original one?
- What are the key differences between ancient pigment and its modern substitutes?

Figure 2. Comparison between the Original Painting(left) and the Modern Replica(right) of Impression Sunrise

Hypothesis

- The subtle difference comes from the pigments. Comparing the market-historical golden pigment with the manuscript-based historical pigment might have different pH value, RGB value and light retention time, for example.

Method

- **Reconstruction**
  - Original Manuscript

To make a very beautiful and inexpensive golden color f.76v

First of all take a very yellow orange peel and carefully remove the white parts, and pulverize it very well it in a very clean mortar. Take the same amount of sulphur, grind all the ingredients together, pour the mixture into a glass vial, and store it in a cellar or other damp place for eight or ten days. When you want to apply it, the mixture needs to be warmed and applied wherever you like, and you will see a very beautiful color.

Good mixture to color gold f.104r

Sulphur & small gravel as much of one as of the other, & the third part of ~~soufr~~ salt, & as much terra merita as sulphur.

  - Modification
    - Pulverize the Orange Peel
    - Cellar Environment
- **Characterization**
  - Medium: Gum Arabica
  - Apply to Plywood Board
  - Comparison
    - Three colors
    - Scientific Description
      - pH Test, Spectrophotometer Test
      - RGB Test, Lightfastness Test
    - Opinion Based Description

Figure 3. Cellar Environment

Figure 4. Gum Arabica, the applied Medium

Figure 5. Resulted Color (f. 76v, f. 104r and Market Historical Pigment, from left to right)

Goal

- **Reconstruct** the historical golden pigment-making process based on BnF Ms. Fr. 640 f. 76v and f. 104r.
- **Compare** the manuscript-based historical pigments against the market historical pigment, by doing pH test, TLC test, photographic documentation and light fastness test.

Result

Reconstruction Result

Table 1. The Resulted Color Comparison Between Three Methods of Pulverizing Orange Peel

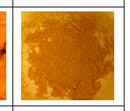
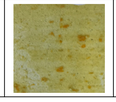
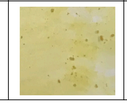
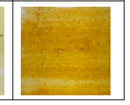
Tools			
Orange peel powder			
Resulted Color			

Table 2. The Resulted Color Comparison Between Different Humidity

Situation		
Humidity	50RH	80RH
Temperature	12°C	12°C
Resulted Color		

Characterization Result

Scientific Description

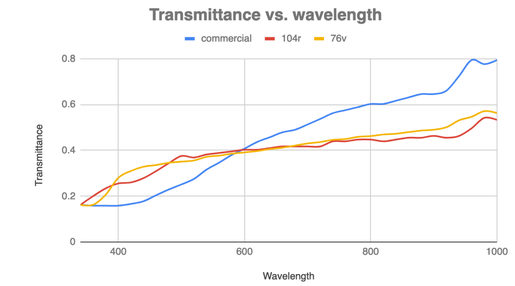


Figure 6. Spectrophotometry graph of Transmittance vs. Wavelength (For f. 76v and f. 104r were Adjusted by Concentration Ratio)

Table 3. pH Test Result

	pH Value
Commercial	6.63
f. 76v	5.54
f. 104r	5.29

Table 4. Light Fastness Test Result

	Delta E	ASTM Lightfastness
Commercial	6	II
f. 76v	2	I
f. 104r	3	I

Figure 7. Pigments after 13hrs Xenon Arc Lamp(a. 76v, b. 104r, c. commercial)

Table 5. Color Documentation

cluster	pixels	name	HEX	RGB
a	29.42%	198,169,94 laser ΔE=2.6	#CAA860	202 168 96
b	26.95%	203,191,160 half pavlova ΔE=2.2	#CABB9C	202 187 156
c	23.63%	203,161,53 satin sheen gold ΔE=3.2	#CCA53E	204 165 62
d	20.00%	198,142,63 anzac ΔE=1.1	#C88F41	200 143 65

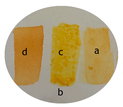


Figure 8. Resulted Color (a. 76v, b. standard 300 GSM watercolor paper, c. 104r, d. commercial)

Opinion Based Description

- "All I used is color of the minerals and plants. I do not use synthetic color in my painting. Although the market pigments may seem finer and more mature, it lacks the authenticity Manuscript Based Pigments resemble. " — Haitao Feng, Professor at Central Academy of Fine Arts
- "76v gives a special color with great potential. However, the particle size needs to be smaller or the pigment should be more water soluble." — Alkan Nallbani, Artist

Discussion & Conclusion

- Reconstruction Process
  - High precision & Environment control
- Characterization Process
  - The quality
    - Manuscript Based Historical Pigments show a better light fastness result than Market Historical Pigments
    - However, manuscript Based Historical Pigments are more acidic, and according to Opinion Based Description, the particle size of Manuscript Based Historical Pigments need to be smaller

Both Strength and Weakness in Manuscript-Based Historical Pigments and Market Historical Pigments

- Colors are similar in general, but they are different in nuance
  - The general trend of transmittance for Market Historical Pigments and Manuscript Based Historical Pigments is similar: the Transmittance increase as the wavelength increase
  - However, Manuscript Based Historical Pigments have a flatter distribution in 450-850 wavelength, while Market Historical Pigment is gradually increasing
  - In RGB test, the R value for three pigments are similar, all around 200
  - But Manuscript Based Historical Pigments have a higher G value in RGB Test

Express a need for Manuscript-Based Historical Pigment

Future Development

- Water Solubility
  - For future use, we need to improve the water solubility of Manuscript Based Pigments
    - Decrease the particle size of the raw material
    - Hydrophilic
- Light fastness test
  - To test the real situation, we can add a outside group by directing exposing the samples under sunshine
- Mass production
  - Time consuming and require delicate work
- Sulphur safety
  - The role of sulfur in the process/ try to find the alternative
  - Safety Protection during its usage

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