A Material Characterisation of Casein Mixtures as Paint Mediums

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Introduction

Casein is a water-soluble binding medium primarily used for easel and mural painting. Recipes mention the addition of oleoresinous materials to casein to provide a water-bound alternative to solvent-borne paints like oil. Based on artists' manuals, oleocasein paints are expected to dry faster than casein and oil and to have a higher surface gloss than casein. This research aims quantify the drying speed, gloss, and degradation stages of oleocasein (OC), made from dammar, a natural resin, and casein, and compare them to casein (CA) and oil (LO) paints.

Experimental

Samples, replicated twice:

- Four pigmented films with Spanish Gold Ochre (Py42h)
- Four unpigmented films of the same ratios as controls

Technical analysis:

- A scribe test to measure drying speed before ageing, based on ASTM D5895-20
- Artificial ageing (162hrs, 34°C, 1.1 W/m^2/m at 420nm) to monitor stages of degradation
- Gloss measurements (60°) to evaluate surface gloss
- Fourier transform infrared spectroscopy to assess changes in chemical compounds

Ratios	CA	OC1	OC2	LO	CA-O	OC1-0	OC2-0	LO-0
Binder to dammar	1:0	1:1	1:2	1:0	1:0	1:1	1:2	1:0
Binder to Py42h	1:0.75	1:0.75	1:0.75	1:0.35	1:0	1:0	1:0	1:0

Figure 1 (top). *Paint films and controls before ageing.*
Table 1 (left). *Formulations of paint films and controls.*

Results and Discussion

Scribe Tests

Pigmented films: Scribe tests on oleocasein films didn't reach the fourth and final drying stage as stated by the ASTM. Interpretations can be made to extrapolate when the films became dry-hard, but scribe tests should be gone again to obtain conclusive results. Varying paint rheology and the use of xylene as a thinning agent likely influenced the results.

Unpigmented films: All films took longer to dry than their pigmented counterparts. OC1-0 and OC2-0 never reached the final drying stage during the prescribed timescale.

Gloss Measurements

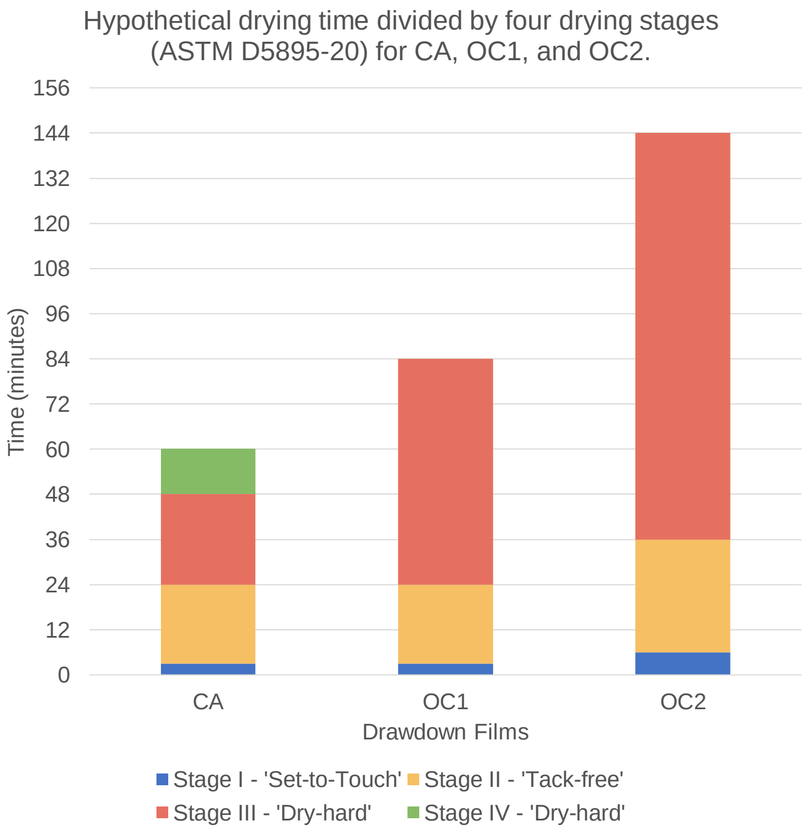
Before ageing: Among the pigmented films, OC2 was the glossiest (19.22 GU) while OC1 was the more matte (1.92 GU). This result was unexpected since resins usually impart gloss. The unpigmented films had the highest values (90-130 GU), making them the glossiest, which was expected since pigments tend to make paint films more matte.

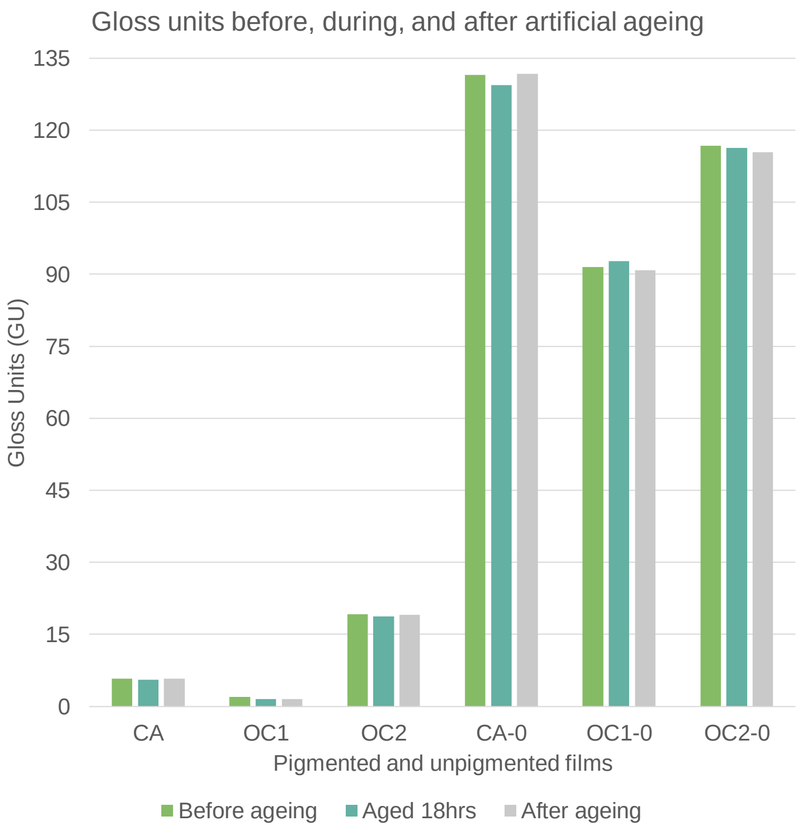
After ageing: Generally, the values decrease over time, but the change is mostly negligible (<5% decrease). The changes are not visually noticeable after 162hrs of ageing, even with OC1's gloss decreasing of 40%.

FTIR

Before ageing: In both pigmented and unpigmented oleocasein films, casein bands are too weak to be discernable. Moreover, variations between the two replicates of one film makes comparison complicated.

After ageing: The comparison of casein to dammar peaks in oleocasein formulations is difficult because of the weak presence of casein bands. The presence of casein didn't seem to affect changes in dammar, and whether dammar affects ageing of casein couldn't be evaluated. Variations in dammar after 162hrs ageing can be attributed to oxidization of the resin.





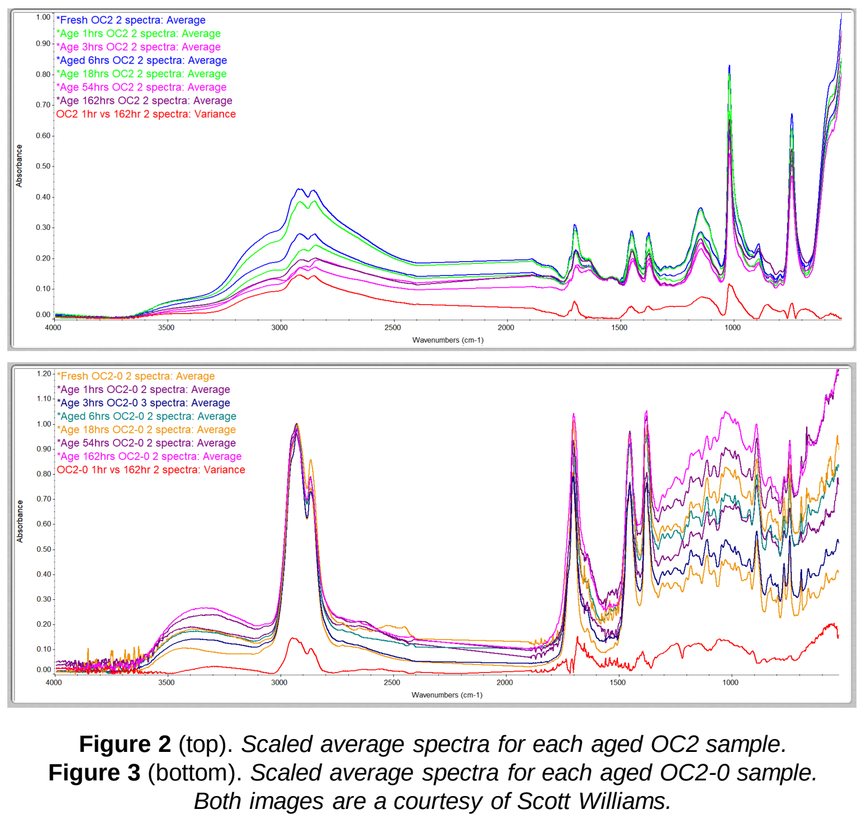


Figure 2 (top). *Scaled average spectra for each aged OC2 sample.*
Figure 3 (bottom). *Scaled average spectra for each aged OC2-0 sample. Both images are a courtesy of Scott Williams.*

Conclusion

The results challenge the hypotheses since pigmented oleocasein films seem to reach the final drying stage after pigmented casein film. Moreover, the addition of resin doesn't equal a higher gloss value in pigmented oleocasein films. While the paint films were carefully prepared, variability could have occurred during the process, for instance the proper mixing of casein and resin emulsions, the amount of dilution, and the films' rheology. All three aspects have a considerable impact on the paint's properties; consequently, standardising the preparation of the paint to achieve a higher level of reproducibility is crucial for future projects.

Selected References

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- Duce, Celia, *et al*. "Interactions Between Inorganic Pigments and Proteinaceous Binders in Reference Paint Reconstructions." *Dalton Transactions: an International Journal of Inorganic Chemistry* 42, no. 17 (2013): 5975–5984.

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