

## Introduction

The research studied blue inks for fountain pens by using Q-Sun Xenon Chamber to artificially ageing 45 samples under controlled conditions. First an investigation on manufacturers' websites was carried out in order to classify the inks, namely dye-based, pigmented and iron gall inks. After 504 hours of ageing, the samples were evaluated by colour spectrophotometer, and results were assessed according to several grouping. In addition, a survey of government institutions, mainly in America, on the type of ink used to sign legal documents was conducted alongside the tests. This research was a collaboration between Queen's University and the Canadian Conservation Institute (CCI), and forms part of an ongoing CCI research project which aims to provide guidelines regarding inks selection for documents of high significance.

## Experimental

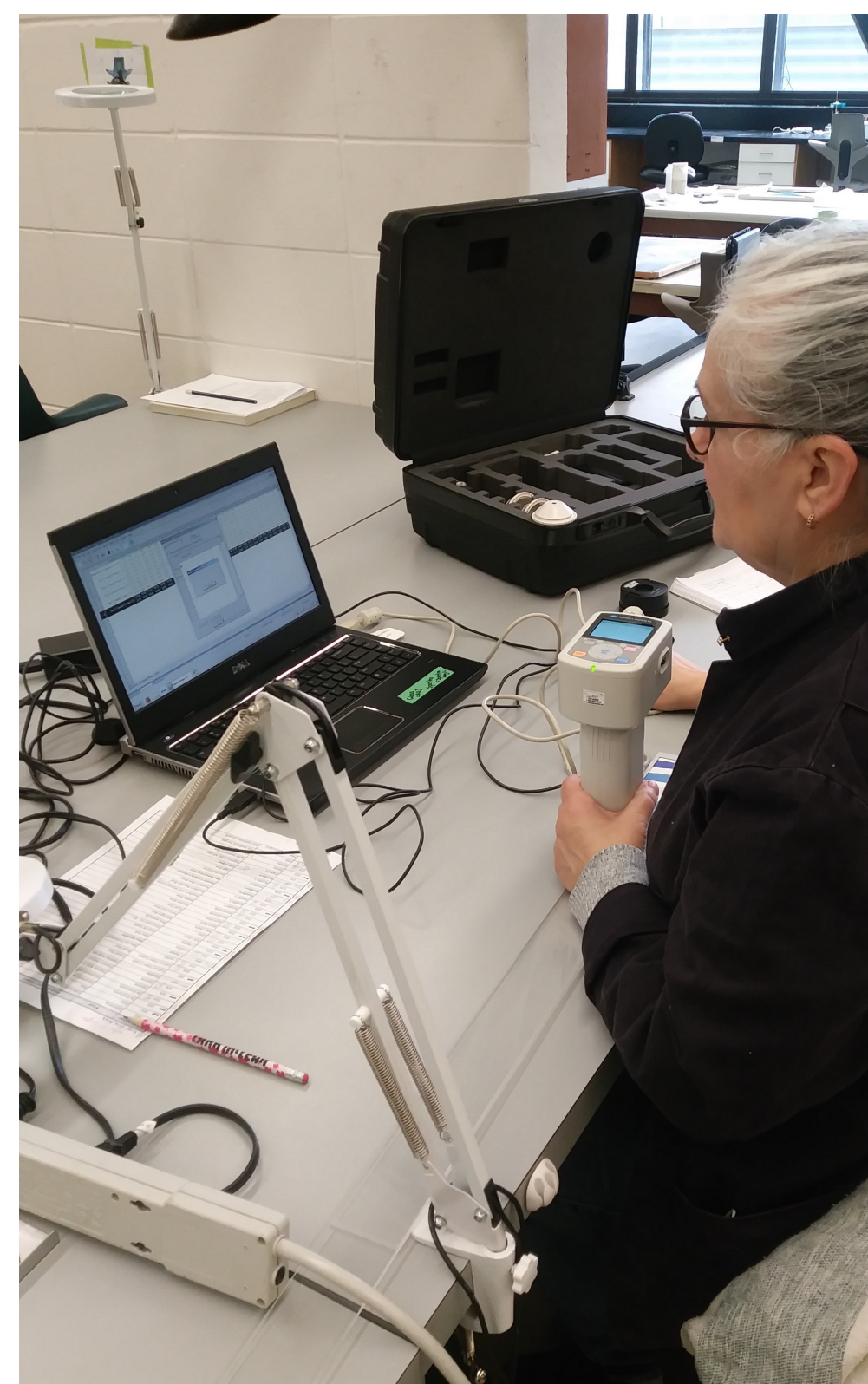
CCI prepared the blue inks samples on acid-free, buffered with calcium carbonate Permalife 25% cotton/75% alpha cellulose paper. The 45 samples, along with Blue Wool scales, were placed in the Q-Sun Xenon chamber, and then were artificially aged at 1.10W/m<sup>2</sup>/nm @ 420 nm at 25°C for 504 hours, i. e. 3 weeks. A Window-Q filter was added to the device in order to replicate the equivalent to direct sunlight passing through a piece of single-strength, single-pane glass of the type most widely used in North America.

Sample measurements were collected 13 times: at time 0, and then after 1, 2, 4, 10, 18, 30, 42, 54, 84, 168, 336 and 504 hours ageing by a portable Konica Minolta Colour Spectrophotometer CM-700d using (CM-A178 target Mask 8 mm plateless for MAV). The five readings taken for each of the 45 samples were averaged by SpectraMagic NX software.

Measurements were taken more frequently at the beginning of the experiment considering that the most changes from light occur early in the ageing process. The calculated illuminance was an hourly light dose of 0.083 Mlxh, resulting in a final light dose of 41.8 Mlxh.



Samples in the Q-Sun Xenon Chamber at Queen's University.

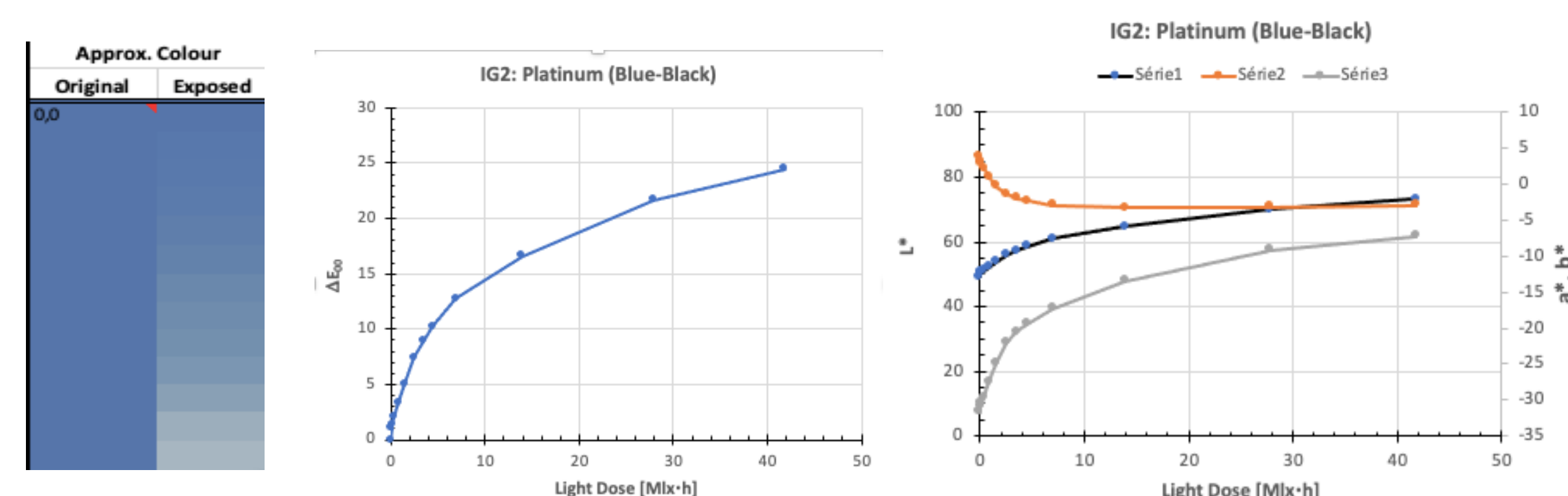


Measurements with the colour spectrophotometer CM700d.

## Results

Results are based on Blue Wool standards which refer to a scale of 1 to 8: 1 being fugitive and 8 being extremely lightfast, and on CIELAB values: L\*, a\* and b\*, respectively lightness, red/green, and blue/yellow.

Below typical results are presented: approximate colour chart, fading curve and CIELAB graphs



Lightfastness result of IG2 Platinum Blue-Black (courtesy of Eric Hagan, CCI).

The results are analyzed by comparison and presented by 11 sub-groups:

1. Inks typically found in large chain stores, such as Staples: One out of four inks performed well.
2. Dye-based inks usually not lightfast: Noodler's Legal Blue-bulletproof performed well.
3. BW5 results for D series (non-pigmented, non-iron gall): Eight inks were BW5 or higher.
4. Noodler's inks bulletproof series: 54<sup>th</sup> Massachusetts, Blue-Black and Legal Blue scored BW5.
5. Pigmented inks: Results showed negligible changes.
6. Iron gall inks: They underwent significant degradation which meant they could be not recommended for signing legal documents.
7. Organics Studio ink: This ink has the particularity of having darkened instead of fading.
8. Brands: The analysis of  $\Delta E_{00}$  results revealed that within the same brand, several qualities of ink can be produced.
9. Manufactures, marketing descriptions:
  - 9.1. Archival inks: a comparison between nine inks designed to be resistant to weathering, not lightfast, six tested BW5, two BW2, and one BW1.
  - 9.2. Permanent, indelible, waterproof inks: Eight of them tested BW5 or higher, one received BW2 and three BW1, therefore they are not necessarily lightfast.
10. Best results for the approximate colour charts: Eight of them tested BW5 or higher, one BW3 and one BW1.

Finally, 10 blue inks for fountain pens were selected as a preliminary recommendation for the legal document signing list.

## Observation and Results

The ink standards survey of government institutions revealed that most of them do not have a law on signing legal documents. Canada and Maryland have e-signature rules on their websites. France, like many states in USA, only refers to the colour of inks. Massachusetts published a bulletin providing for the use of inks for high significance documents. Nevada stipulates a non-fading or waterproof ink depending on the form to be filled. Overall, the recommendation letter for the choice of ink for signing official documents sent on April 14, 2016, to federal departments and agencies by Guy Berthiaume of LAC, and involving the conservator Anne Maheux, appears to be a rare interest in the lightfastness of the ink.

## Conclusion

As expected, pigmented inks gave good results as well as the Noodler's Bulletproof series. Except Uniball pen, identified as permanent, inks commonly found in large chain tested BW2. Dye-based inks were generally not lightfast, although testing yielded two good results: Noodler's Legal Blue and Pilot Iroshizuka Asa-Gao. Historical documents written with iron gall inks retained their colour, so the BW1 results for the four iron gall ink samples were unexpected. The photochemical reaction of the Organics Studio ink darkened and changed the hue of the ink which makes it valuable to sign high significance documents.

D03 – Atramentis Document-Blue	D04 – Atramentis Document-Dark Blue	D14 – Koh-I-Noor Document-Blue	D19 – Mont Blanc Permanent Blue	D23 – Noodler's 54th Massachusetts	D34 – Pilot Iroshizuka Asa-Gao	D41 – Rohrer & Klingner Documentus-Dark Blue	D42 – Rohrer & Klingner Documentus-Light Blue	D46 – Sailor Ink Studio 743	D31 – Organics Studio Nitrogen
Approx. Colour Original Exposed	Approx. Colour Original Exposed	Approx. Colour Original Exposed	Approx. Colour Original Exposed	Approx. Colour Original Exposed	Approx. Colour Original Exposed	Approx. Colour Original Exposed	Approx. Colour Original Exposed	Approx. Colour Original Exposed	Approx. Colour Original Exposed

Based on approximate colour charts, a final table presents preliminary recommendations for signing legal documents.

## Acknowledgements

Thank you to  
Dr. Alison Murray  
Dr. Eric Hagan  
Crystal Maitland  
Dr. Anne Maheux

for sharing their experience and knowledge, and for their support.