Colour Stability in Ron Mueck's Silicone Artworks

Charlie Carroll and Anna Carroll (MA Cons)

Image from Ron Mueck's studio provided courtesy of Ron Mueck *© Ron Mueck*

Introduction

The long term colour stability of pigments has been well studied with investigations dating as far back as the 1st century BCE[1]. Consequently, artist paint manufactures pay detailed attention to the stability and light fastness of the pigments used in their products. In fact it is common practice to put the ASTM light fastness rating and CI pigment number on the tube of paint.

Artworks continue to possess aesthetic and investment value as culturally significant objects, consequently it is important that new works can be, in a sense, guaranteed for the future.

Artists continue to explore different ways of producing works of art and have as a consequence adopted materials that have not necessarily been evaluated with long term stability in mind.

Ron Mueck is a hyper realist sculptor who reproduces the human form in minute detail; distortions in scale make the works both familiar and disconcerting, producing visually complex and compelling works. To produce these sculptures Mueck borrows materials and techniques more commonly associated with industrial moulding and the special effects industry.

The silicones and pigments supplied to this industry are generally intended for short term use and little or no attention is paid to their long term stability; typically a prosthetic appliance made from these materials would be expected to have a lifespan of a single day's shoot. As opposed to dedicated artist materials, pigments sold in this industry do not come with light fastness recommendations or any information about their composition.

Purpose

The purpose of this study is to compare the colour stability of the generic FX pigments currently used by Mueck with those produced by Spectromatch Ltd.

The pigments produced by Spectromatch have been formulated for Ron Mueck with long term light stability a primary concern.

The data collected from this study will inform safe lighting level guidelines for Mueck's silicone artworks.

[1] Vitruvius' treaty De Architectura found in Lavérdine, B. (1998) The Blue Pink Scale: a new light dosimeter for the exhibition of photographs and sensitive artefacts. In: Care of photographic moving image & sound collections, York, England, 20-24th July 1998. UK: Institute of Paper Conservation. pp124-8.

Sample preparation

Samples were produced to mimic, as closely as possible, the colour and method used by Mueck in producing his pigmented silicone artworks.

For the most part two colour blends are used to colour the silicone; 'pinky' and 'ivory' pigment blends. Once the desired colour and opacity is achieved a thixotropic agent is added to the silicone to increase its viscosity to that of a paintable paste.

Firstly, the 'pinky' silicone is applied at various thicknesses to the inside of the mould; secondly the 'ivory' silicone is painted over the back at a thickness of around 10-15mm.

Accurately reproducing this method in a controlled consistent way to produce test samples proved problematic — it is very hard to get a repeatable thickness that can be used as a like for like comparison.

It was decided to create a standardised sample from a 'pinky' swatch at 0.5mm thickness, and an 'ivory' swatch at 7mm thickness using a mould tool to guarantee consistency. These swatches were adhered together with a thin layer of clear silicone to replicate the painting process. Mueck's preferred silicone; a two part addition cure liquid silicone elastomer (RTV A400 from Jacobson Chemicals) was used.

In total, two sets of seven samples were produced using Mueck's original generic FX pigments and the new Spectromatch's pigments.

In addition, two samples were produced by Mueck using each pigment set to replicate his methods exactly. These samples were produced to provide a visual guide of the colour deterioration and to assess the standardised sample's ability to replicate the fading pattern.

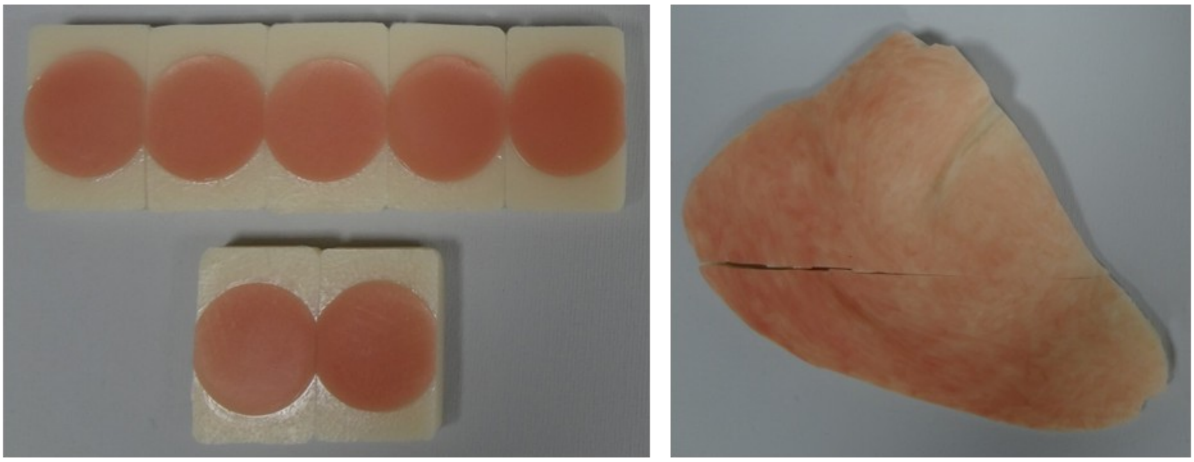


Figure 1 *shows the makeup of the different types of sample with the standardised sample on the left and the Mueck made sample on the right.*

Light exposure

The light sensitivity of the samples where independently tested by Kings College London using a Q-Sun Xenon Test Chamber model Xe-1-BC manufactured by Q-Panel Ltd. The irradiance level on the samples was set to 1.10 w/m^2 at 420nm with a black panel temperature of 40 °C; this is intended to simulate the spectral equivalent of strong sunlight coming through window glass.

Figure 2 *shows five samples made with each set of pigments and the two Mueck made samples in the test chamber.*

The remaining two standardised samples were used as controls. The Mueck made test samples were cut in half, one half was exposed and the other used as a control. All control samples were kept in a black box for the duration of the experiment.

The standardised samples were measured at every 100 hours of exposure using a Konica Minolta Cm2300d Spectrophotometer. A measurement rig was used to ensure that exactly the same area on each sample was measured each time.

The samples were tested for a total of 1000 hours.

Results and Analysis

The following graphs and images show the results of this experiment.

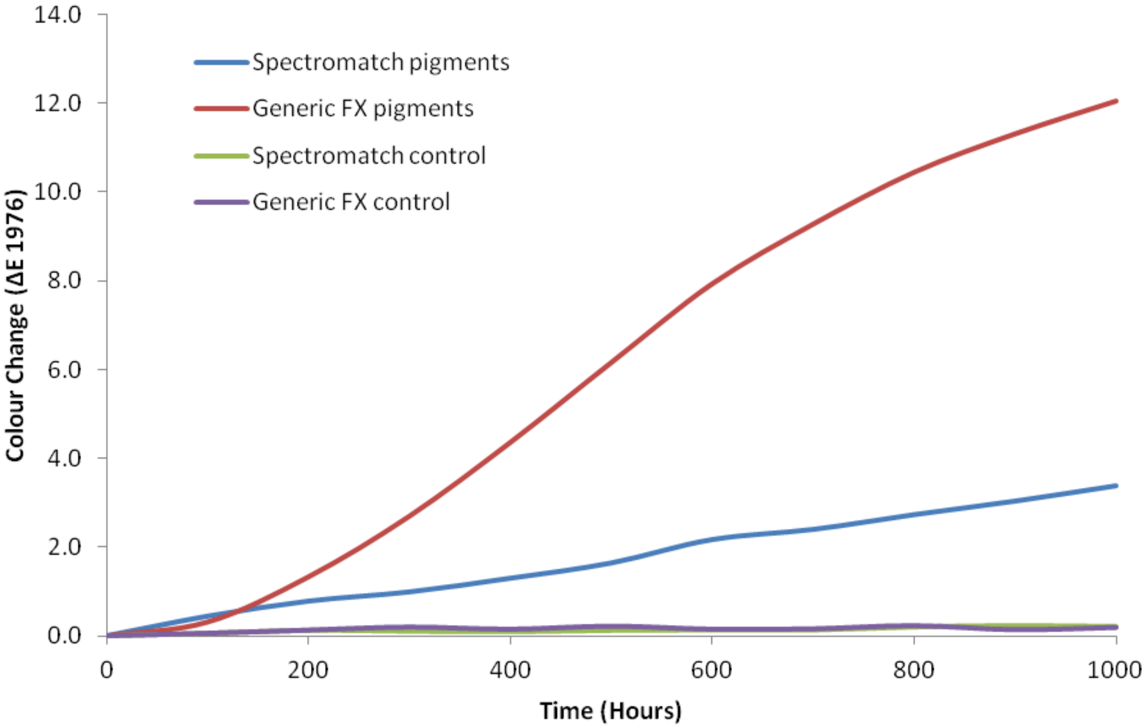


Figure 3 *shows the results of the standardised samples plotted with time in hours against ΔE 1976 with the average of the five measurements shown. In addition the averages of the two control samples are shown.*

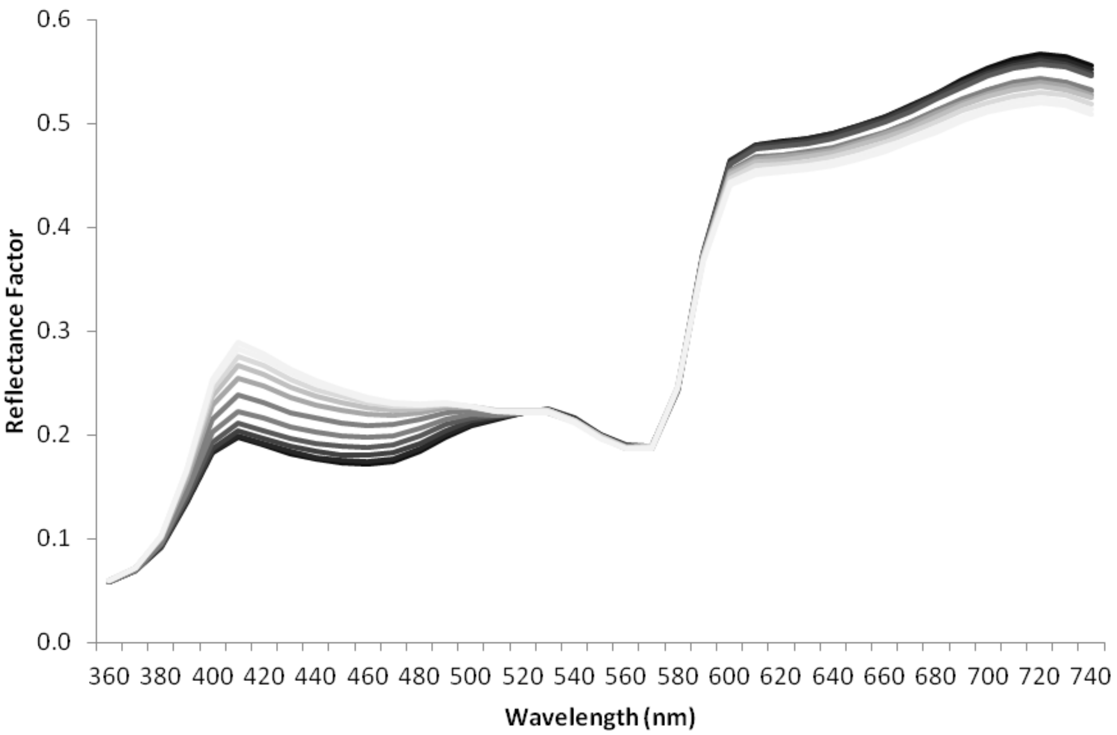
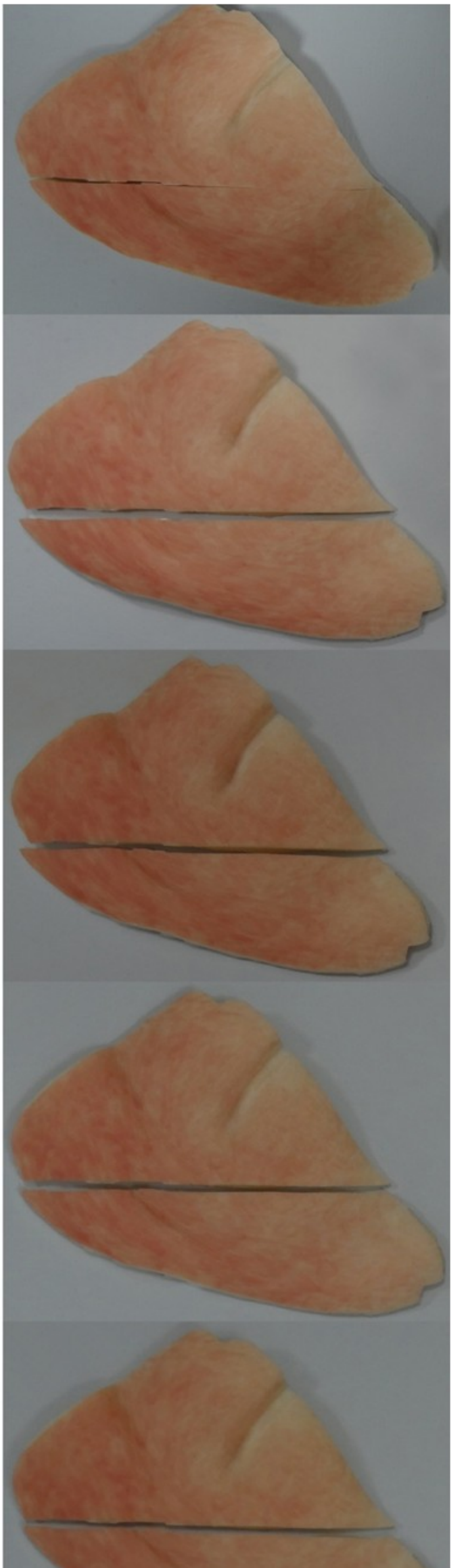


Figure 4 *shows the fade of the generic FX pigments over the visible spectrum the darkest line being the earliest measurement. Significant areas of colour change can be seen, the sample has become much bluer.*

Mueck made samples using Spectromatch pigments

Mueck made samples using *generic FX* pigments



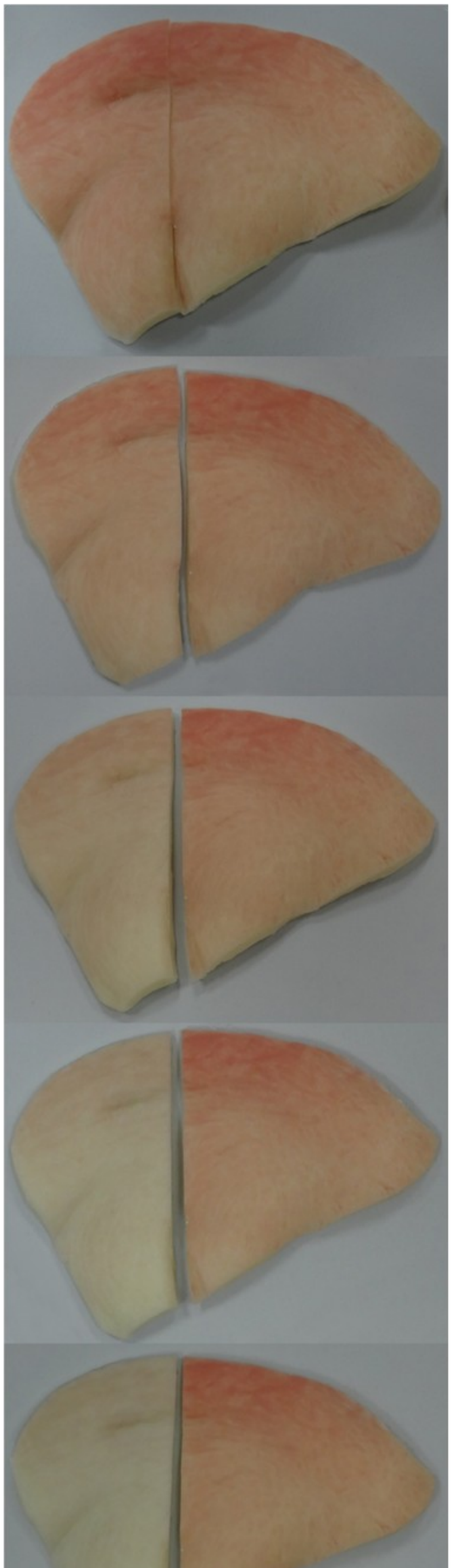
0 hours

100 hours

200 hours

300 hours

400 hours



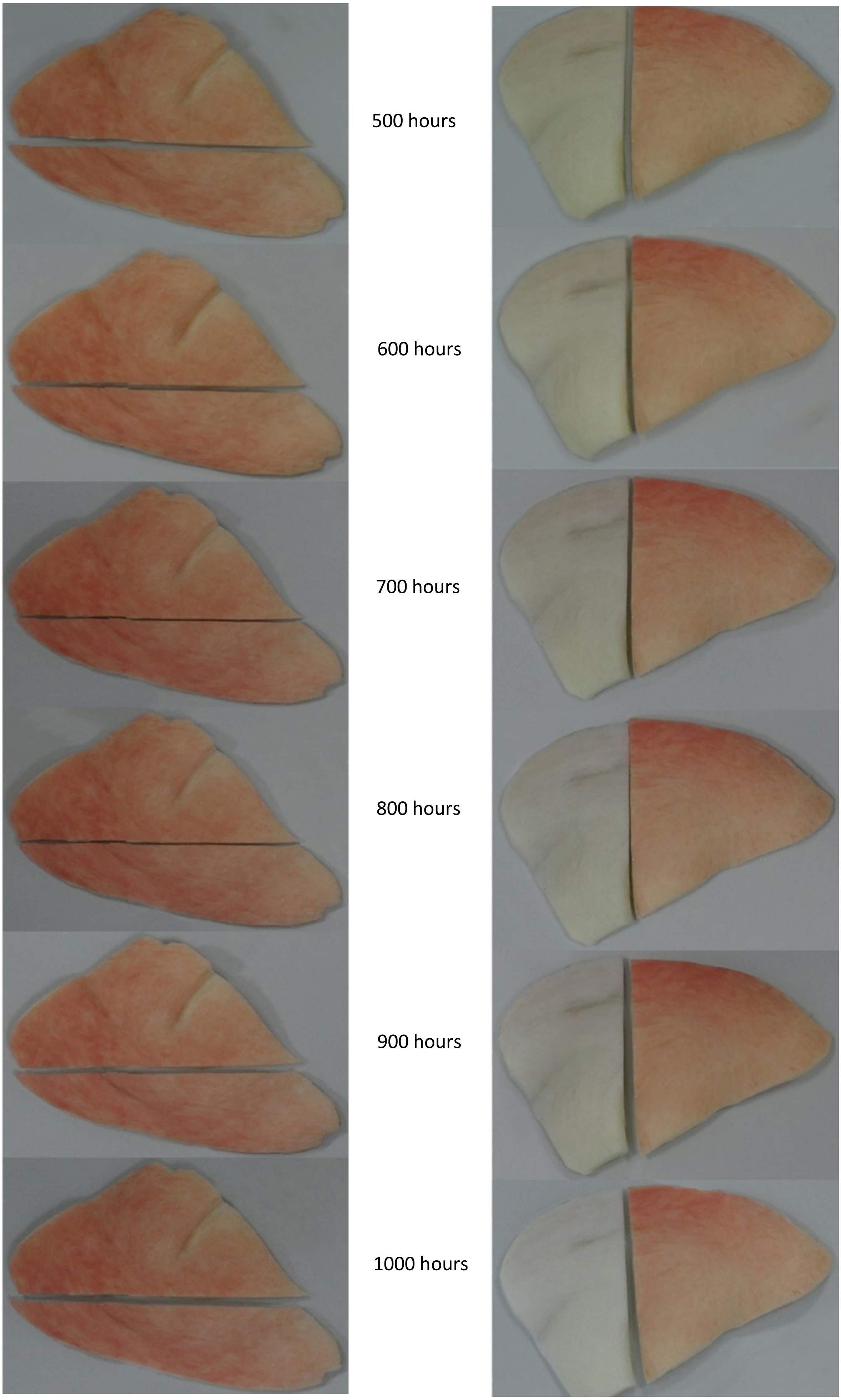


Figure 5 *shows the fading of the test samples with the two halves photographed together at each 100 hour measurement point.*

By the final 1000 hours the standardised samples made with Spectromatch pigments showed a colour change of 3.4 ΔE 1976 and the generic FX pigments showed a difference of 12.1 ΔE 1976.

In the Mueck made samples the generic FX pigments have completely faded whereas the Spectromatch pigments continue to fair well.

From these results we can see that the Spectromatch pigments significantly outperform the generic FX pigments in both sample types.

The results measured in the standardised samples are broadly similar to the level of fading observed in the Mueck made samples. However there is a difference in the type of colour change seen, much more of the red is preserved in the standardised samples.

It is worth noting that this inconsistency could be, amongst other things, due to the variability of the layer thicknesses in the test samples and the proximity to the light source.

Recommendations

It is generally considered that there is a linear relationship between the intensity of the irradiance and the time of exposure[2], therefore with caution we can use the test data to estimate the expected level of change for a given time period at a specified lighting level.

Relating testing results to real time is fraught with error as there are so many factors that can influence fading. It is almost impossible to know in advance the likely exposure of any object in the real world. However, due to the importance and value of their collections Museums and Galleries pay special attention to their lighting levels. We can therefore know with a reasonable level of certainty the irradiance that their collections are exposed to.

It is standard industry practice for Museums and Galleries to use Lux (a measure of the light intensity, as perceived by the human eye) to monitor the irradiance of their light sources. Our test chamber setting of 1.10 w/m^2 at 420nm equates to 89,000 Lux.

Putting this into context, you would expect to find the following Lux readings in these various situations:

Lux Level	**Real World Situations**
50	Gallery displaying light sensitive works of art such as watercolours[2]
100	Very dark overcast days[3]
200	Museum or gallery displaying less light sensitive items such as oil paintings[3]
320-500	Office Lighting[4]
1000	Overcast day, studio, supermarket[3,4]
10,000-25,000	Full daylight (not direct sunlight)[3]
32,000-100,000	Direct sunlight[3]

Figures 6 and 7 below show how the test conditions roughly equate to the risk of photodegredation at exposure levels from 50-100,000 Lux based on a typical day's exposure of 8 hours, 7 days per week, and 52 weeks per year.

The assessment is based on a visual examination of the Mueck made test samples, where acceptable change is shown by the amber blocks and unacceptable by the red blocks. At this point acceptable change is very subjective, however an amber square would suggest minimal but perceptible change and red would suggest significant change that would certainly alter the viewing of the piece.

[2]Thompson, G. (2005). The Museum Environment 2nd Edition. Oxford: Betterworth-Heinemann.
[3]Wikipedia. (2014). Lux (Internet) Available from http://en.wikipedia.org/wiki/Lux Accessed 1 April 2014.
[4]The Engineering Toolbox (2014). Illuminance-Recommended Light Levels (Internet) Available from http://www.engineeringtoolbox.com/light-level-rooms-d_708.html Accessed 1 April 2014.

Generic FX Pigments

Figure 6 *shows the likely colour change of the generic FX pigments for a given period of time against the lighting lux level. The amber blocks indicate an acceptable amount of change and the red blocks indicate an unacceptable colour change.*

Spectromatch Pigments

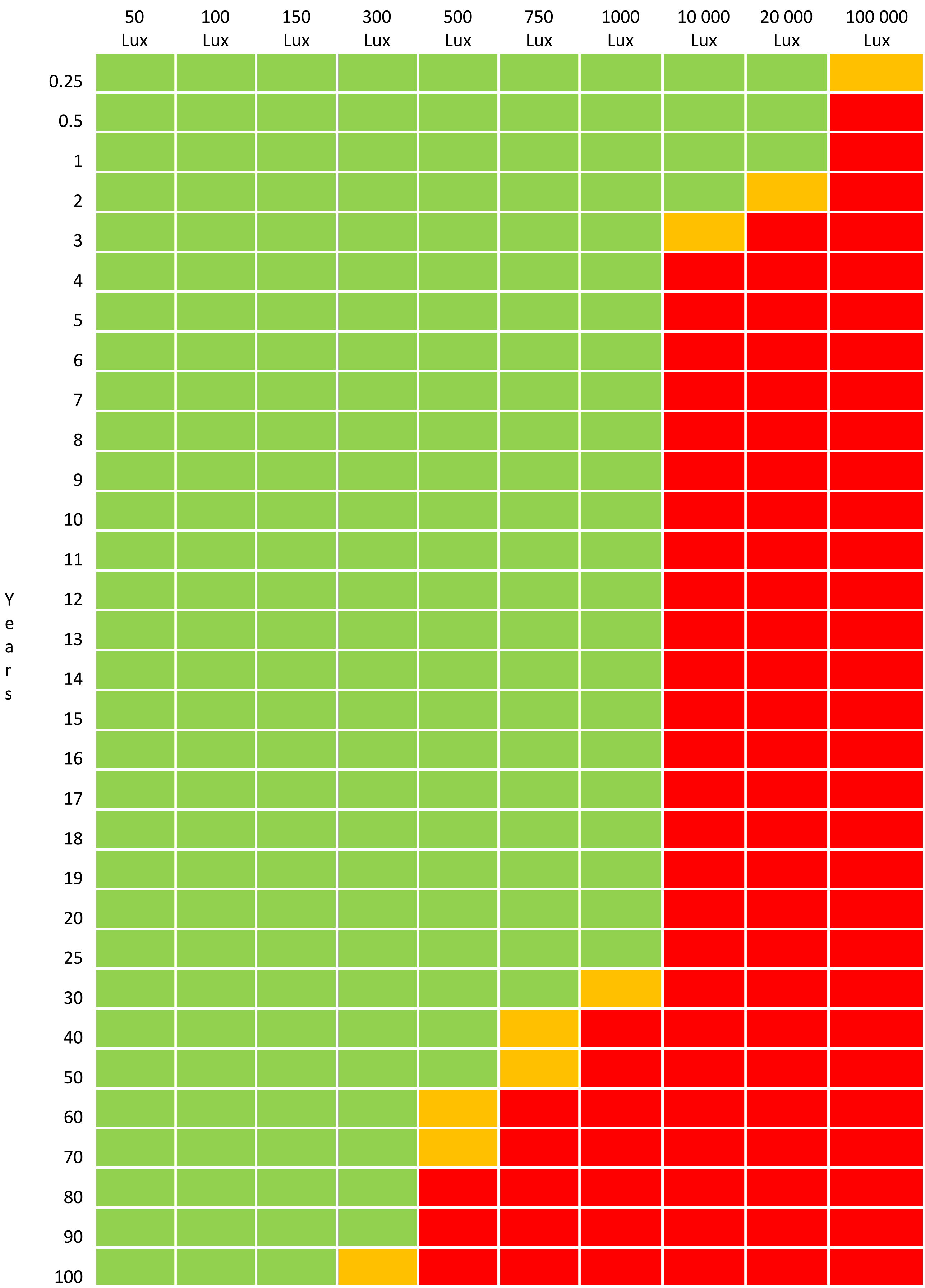


Figure 7 *shows the likely colour change of the Spectromatch pigments for a given period of time against the lighting lux level. The amber blocks indicate an acceptable amount of change and the red blocks indicate an unacceptable colour change.*

The recommendations made are cautious due to:

- The subjective nature of the assessment as the acceptability threshold is based on a visual assessment of the colour change only.
- The fact that the pigment loading of Mueck's pieces varies, the more opaque pieces will likely show better resistance to fading.
- The use of Lux to interpret the results has its limitations when considering photodegredation.

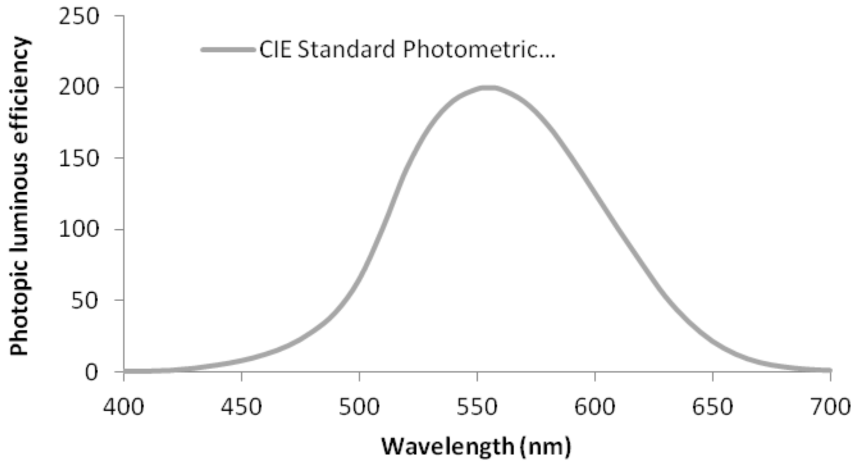


Figure 8 *Shows how the lux measurement fails to take into account many of the more damaging areas of the spectrum - at 400 nm, exactly the region where the eye's response is dropping to zero; we find the most damaging powerful radiation that is likely to cause most damage*[5].

In addition it must be noted that different light sources have very different spectral power distributions (see figure 9), for example, tungsten, LEDs or sunlight will all have very different influences on photomechanical degradation.

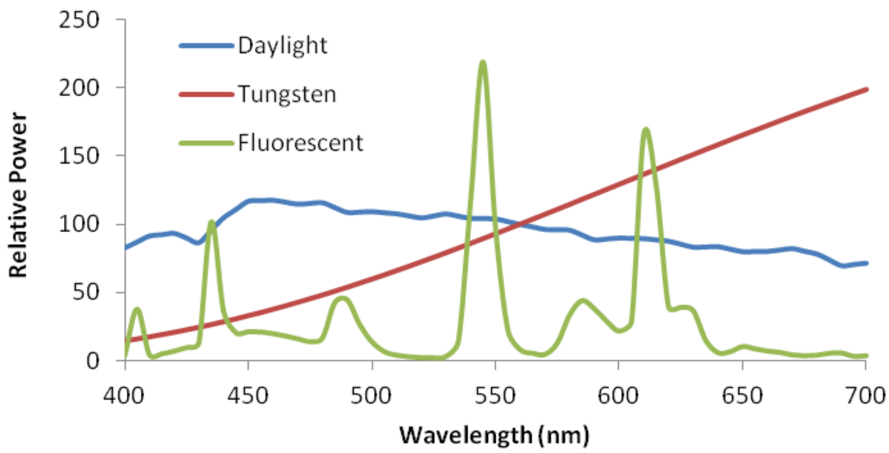


Figure 9 *Shows how common light sources can have very different spectral power distributions.*

A tungsten light source will have very little power at the blue end of the spectrum whereas daylight will have a much higher power and will in all likelihood be more damaging. Hence, it would be recommended to use a light source such as the low-colour temperature incandescent filament light source or tungsten light sources.

[5] Brommelle, N. S. (1964). Russell and Abney Report on the Action of Light on Watercolours. In: Studies in Conservation, Vol. 9, Issue 4, pp. 140-152. 1964, p147

Conclusion and further work

A number of things may be explored further to improve our understanding of the fading of these pigments:

- Exposing the pigments to irradiance filtered to a series of narrow wavelength bands would give us a better understanding of the areas of the spectrum that cause most damage. This would enable a more accurate prediction of the colour change under different light sources and to recommend one type of light source over another.

- Develop a method of sample production that more accurately represents the method used to produce the final artworks and shows the same level and type of fading we have seen in the samples produced by Mueck.

- Further testing of the generic FX pigments, measuring the samples more frequently (every 20 hours) and at a lower irradiance to gain a more accurate time frame for when the samples start noticeably to change colour and when that change becomes unacceptable to the human eye.

- Further testing of Spectromatch pigments, exposing the samples for longer to gain an understanding of their ongoing behaviour and at what point the colour change becomes unacceptable to the human eye.

Finally and perhaps most importantly, more may be done to improve the stability of Spectromatch pigments:

- Exploring the possibility of incorporating a UV absorber into the pigment formulation as a further shield against photodegredation.

- Develop more robust pigment combinations; some pigment combinations will be less susceptible to colour change or that photodegredation in one pigment will have less impact on the overall colour.

In conclusion, we can clearly see that the Spectromatch pigments perform considerably better than the generic FX pigments and that the lifetime of Mueck’s artworks under typical gallery conditions has been significantly increased.

We hope that the data presented here will be of value to private collectors, museums and galleries when displaying Mueck’s silicone sculptures.

A note of thanks

We would like to thanks Ariane Farah and Dr Trevor Coward of King's College London for their time and support with this project. A special thanks to Ron for his time, input, support and for providing materials.