Standardisation for the Graphics Industry Using Ceramic Colour Standards

Lee Bullock and Sean Hillman

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Abstract

Standardisation and control of colour measurement for the graphics and print industry has relied on the use of proofing paper as a substrate to assess print reproducibility via measurement of a CYMK media wedge to ISO 12647-7:2004 AMD 1. Due to inherent chemical instability however, chromaticity of proofing paper may shift due to oxidation and thus discolour. Ceramic colour standards have been used in other industries that rely on colour management for their product requirements and quality control since the introduction of the CCSI Set (Ceramic Colour Standards – Series 1) in 1969 and the current version, the CCSII Set has been in service since 1983. Ceramic colour standards have the advantages of being chemically and colorimetrically stable over time in different environmental conditions.

It is proposed that proofing paper chromaticity can be standardised and controlled for drift using white ceramic standards that are traceable back to national metrology laboratory measurements. Standardisation and control can be undertaken by reflectance measurements in 0:45a geometry defining two sets of colorimetric parameters commonly used in the graphics industry, namely CIE 1931 L*a*b* colour space under D50/2° standard illuminant and observer and corresponding chromaticity coordinates xyY, to define a set of values of the standard reference.

This will provide Quality Control data for the chromaticity of proofing paper and as such; repeatability and reproducibility via traceable standardisation of common colorimetric parameters. This can be combined with inter-laboratory comparison programs for standard chromaticity measurements of a white standard for spectrophotometers. Expanded uncertainties in accordance with the GUM (Guide to Uncertainty in Measurement) can also be provided for the colorimetric parameters in accordance with ISO 17025:2005 for testing and calibration in order to easily assess the performance of proofing paper against national standards.

Lucideon

Introduction

Prior to the introduction of ceramic colour standards industry colour standards were manufactured from the same materials as the products themselves. There was a need for long term continuity of colour references and new materials were employed to facilitate this including glazed ceramic tiles. The chemically inert nature of ceramic tiles meant that greater confidence could be assumed in the verification of measured colour coordinates of products. It is proposed that a robust and reproducible chromaticity standardisation methodology for proofing paper is needed to control colour measurements on spectrophotometers between different instruments and production environments.

It is proposed that the graphics and print industry could greatly benefit from the use of a ceramic white standard to emulate and thus standardise the colorimetric characteristics of the Semimatte 250 proofing paper currently in use as it would be chemically stable over time and in different environmental conditions whilst maintaining well defined colour characteristics that are traceable back to a national metrology laboratory – for instance NPL (National Physical Laboratory, UK). Thus this paper is primarily concerned with the formulation, production and traceability of a white ceramic colour standard that is optimised to reproduce as well as possible the reflectance spectra and CIE 1931 colorimetric parameters under D50 illumination and 0:45a geometry of GMG produced Semimatte 250 proofing paper. This could provide a robust, reproducible and universal reference standard to assess the chromaticity measurements xyY and the CIE 1931 L*a*b* colour space under D50 illumination and 0:45a geometry of proofing paper used in the graphics and printing industry.

Methodology

Specification of Semi-Matte 250 Proofing Paper

The GMG produced Semimatte 250 proofing paper was measured by a spectrophotometer under D50/2 illumination, standard observer and 0:45a geometry. The reflectance spectra $R(\lambda)$ was recorded in 10 nm wavelength steps in the visible band between wavelengths of 400 nm and 700 nm. Colorimetric values under D50/2 such as the chromaticity values xyY and CIE 1931 L*a*b* colour space would also be recorded.

Results of measurements1 conducted by BST Eltromat International GmbH for the Semimatte 250 and Semimatte 250 GP of reflectance spectra and corresponding colorimetric xyY (X and Z are also shown in the table) and CIE 1931 L*a*b* values can be found in Figure 1 and Table 1 respectively.

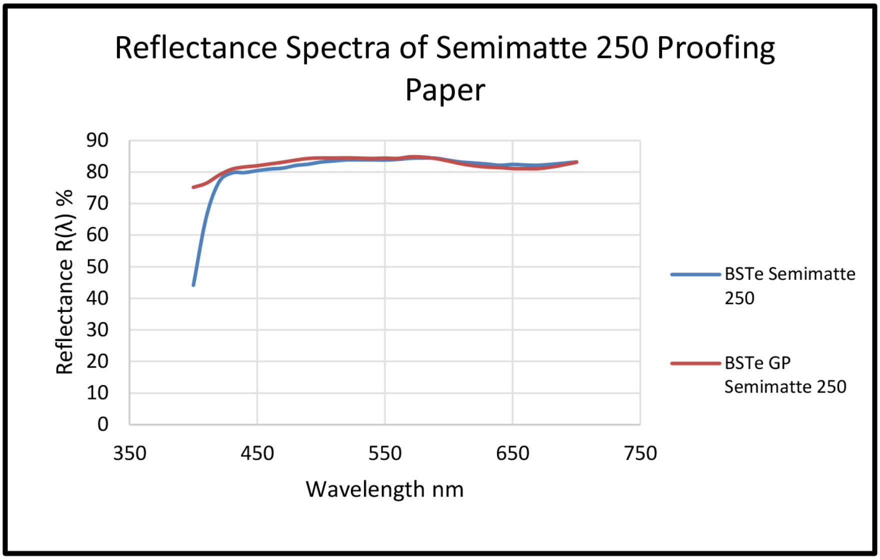

Figure 1₁: *0:45a reflectance spectra of the Semimatte 250 and the Semimatte 250 GP as measured by BST Eltromat International GmbH.*

Sample	L*	a*	b*	X	Y	Z	x	y
Semimatte 250	93.29	-1.19	2.48	79.95	83.64	66.24	0.3479	0.3639
Semimatte 250 GP	93.43	-1.62	1.28	80.03	83.96	67.78	0.3453	0.3622

Table 1: *Derived D50 illuminant and 2˚ standard observer colorimetric values – CIE 1931 L*a*b* colour space, tristimulus values X, Y and Z and chromaticity coordinates (x, y). Derived by Lucideon from the reflectance spectra measured by BST Eltromat International GmbH.*

Glaze Formulation

Glaze formulation is informed by the matching of the reflectance spectra to the target specification. This is done as an iterative process of tile production trials and 0:45a reflectance spectra measurement using a suitable spectrophotometer. When trying to develop a ceramic colour standard it is best practice to match R(λ) as opposed to matching the colorimetric coordinates such as CIE L*a*b* colour space as two different reflectance spectra responses can gives comparable ΔE values less than 0.5 but may exhibit a large metameric effect under different illuminations and geometries.

Once the reflectance spectra has been matched an assessment of the ΔE colour difference in CIE 1931 L*a*b* colour space is carried with an acceptance criteria being ΔE < 0.5. Once this is achieved then volume production of the new white standard can start.

Standardisation and Traceability

Once an optimised colour standard is accepted, a master standard tile is submitted to a national metrology laboratory for traceable calibration in accordance with ISO 17025:2005 (testing and calibration). The chosen metrology laboratory is NPL (National Physical Laboratory) and the measurements are traceable to the "NPL-2007" scale definition for the perfect reflecting diffuser. The master standard tile is then kept for all future batches of the new standard to be matched to.

In accordance with ISO 17025:2005 with UKAS accreditation for testing and calibration a comprehensive uncertainty budget will be produced in line with the GUM (Guide to Uncertainty in Measurement)[2] in order to easily assess the performance of individual spectrophotometers against national standards. Uncertainties in spectral reflectance and colorimetric values sourced from the calibration procedure by NPL and subsequent repeatability trials in-house shall be folded-in in line with this methodology to produce expanded uncertainties in reflectance of the form (Equation 1[3]).

$$\Delta R = a + bR + c\frac{dR}{d\lambda} \qquad \text{Equation } 1_3$$

Where a is the zero error, b is the linearity coefficient and c is the uncertainty in the wavelength scale or the slope coefficient. Uncertainties in colorimetric values of measured results are also analysed with absolute accuracy uncertainties sourced from NPL folded into the repeatability trials. The coverage factor to generate expanded uncertainties is then based on the degrees of freedom and the t-distribution.

Best Practice and Use

Care of Colour Standards[4]

Care of instruments and material standards should be in line with laboratory best practice and colour standards must be kept clean, scratch-free and checked regularly for any cracks or damage if in constant use.

Colour standards should always be held at the edges to avoid soiling of the measurement surface with fingerprints. If faces do become soiled they can be cleaned with a soft lint-free cloth or tissue paper. Heavier soiled surfaces can be cleaned with a solution of laboratory grade detergent (containing no bleaching agents, thickeners or colouring agents) or Propan-2-ol (Isopropyl Alcohol) and allowed to air dry. Any cleaning should be carried out with the minimum of mechanical pressure and polishing action should be avoided[4].

Although white ceramic standards exhibit very little thermochromism and are chemically stable they should not be exposed to high levels of moisture, heat, UV, sunlight or ionising radiation and should never be immersed in water. Ceramic colour standards should be stored in their protective box when not in use and should be given time to stabilise to laboratory temperatures before use[4].

Use of the Standards in the Graphics and Print Industry

The new white ceramic colour standard may be used in conjunction with the Semimatte proofing paper and could provide a powerful tool in standardising the chromaticity xyY of proofing paper to FOGRA39 (referencing ISO 12647-2:2004 AMD 1) for printing applications. This would provide traceable QC data for the stability of the white point x,y of proofing paper used in service to ensure repeatability and reproducibility via traceable standardisation of common colorimetric parameters in particular when used with inter-laboratory comparison programs for spectral reflectance and chromaticity.

References and Acknowledgements

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