Evaluation of Available ISO 13655 Backing Materials and Measurement Differences for the Packaging Industry

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Content overview

- Project Goal
- Standard Guideline and DOE
- Understanding the Variances

It was a snowy day in New England…

Project goal

We need to identify some ISO 13655 compliant backers that are easy to obtain with cost in mind…

Project goal

Current common status in the industry

- ISO 13655 Annex A – Good approach
- Reality from various aspects of the industry?

Example 1

Litho sheet-fed press console with a dark grey, glossy, metal surface backing that came from press manufacture

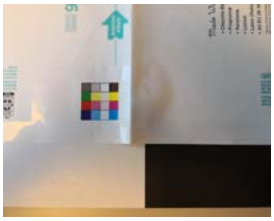
Example 2

Litho sheet-fed press console with a laminated melamine white board. Also used as a cutting table.

Example 3

From a offset printer's ink room. Ink technician mixing base inks on a glass surface with white sheet underneath. The same surface are used as measurement backer.

Example 4



At a flexible packaging printer QC room. Translucent film are measured with a contrast card as backing for color and opacity.

Example 5

An in-line Spectro device mounted on a flexo or continuous-fed printing press, which has a specially painted white backer.

Standard guideline

- ISO 13655 (2017) – Spectral measurement and colorimetric computation for graphic arts images
  - *Annex A – Sample backing*
    - Standard Black Backing (BB)
    - Standard White Backing (WB)

Standard guideline

A.2 Standard black backing

Black material shall conform to ISO 5-4.

ISO 5-4 requires the following properties:

- spectrally non-selective, i.e. the total range of spectral diffuse reflection density throughout the wavelength interval from 400 nm to 700 nm does not exceed 5 % of the average density obtained over the same interval;
- it should be diffusely reflecting (e.g., little or no perceptible specular reflection when viewed at any angle less than 45° from the normal, under typical office room illumination conditions). As black materials with a matte surface are prone to physical damage the black backing material should be semi-matte (ISO 8254-75° gloss less than 40 GU);
- opaque substrate;
- minimum ISO 5 visual reflection density of 1,30;
- maximum ISO 5 visual reflection density of 1,60.

Standard guideline

A.3 Standard white backing

White material shall have the following characteristics.

a) It shall be opaque (e.g., ceramic, plastic or paper). The opacity shall be equal to or greater than 99.

$$O_B = (Y_B/Y_W) \times 100 \qquad (A.1)$$

where

O_B is opacity (2°/65°, 10/d, 2°, Y) of the backing material;

Y_B is the CIE Y value computed from measurements made using black backing conforming to A.2;

Y_W is the CIE Y value computed from measurements made using a stack of at least three sheets of the material to be used for backing.

b) It should be diffusely reflecting (e.g., little or no perceptible specular reflection when viewed at any angle less than 45° from the normal, under typical office room illumination conditions – typically referred to as a matte appearance). As white materials with a matte surface are prone to physical damage the white backing material shall be semi-matte (ISO 75° gloss less than 40 GU).

NOTE 1 Many print shops do not own an ISO 8254-75° glossmeter. However, as gloss tends to increase as the angle increases, the same tolerances can be used with angles of 60° or 85° as used with inks and coatings.

c) Its CIELAB C* value shall not exceed 2.5.

d) It shall be non-fluorescing (no emission in the response band of interest when excited by the instrument sources). This is equivalent to reading the backing sheet with M1 and M2 modes and the differences at any wavelengths greater than 410nm shall be less than or equal to 3σ (3 standard deviations) of 5 readings of the backing sheet using only the M2 mode.

The spectral reflectance factor values shall be within the range of the curves given in Table A.1.

NOTE 2 While the data in Table A.1 are described as conforming to ISO/CIE geometry 0°:45°, this does not preclude the use of an instrument with 45°:0° geometry since the backing is required to be diffusely reflecting and as such will follow the Helmholz law of reciprocity so that the readings from the two geometries will be identical.

- Experiment configuration
  - *Measurement devices:*
    - TECHKON SpectroDens 4

      Geometry – 0:45 optics according to ISO 5-4

      Light source – LED, provides M0, M1, M2, M3 measurement conditions according to ISO 13655

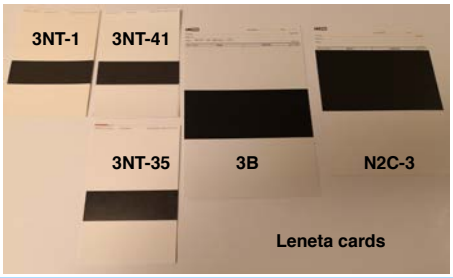
    - 3NH Gloss meter YS60S

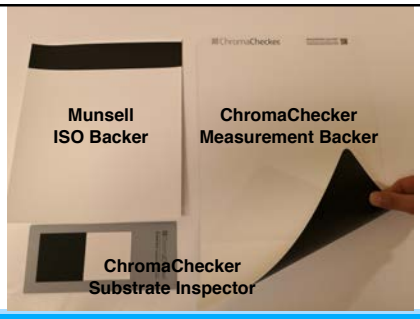
      Geometry – 60° gloss meter according to ISO 2813 and GB/T 9754

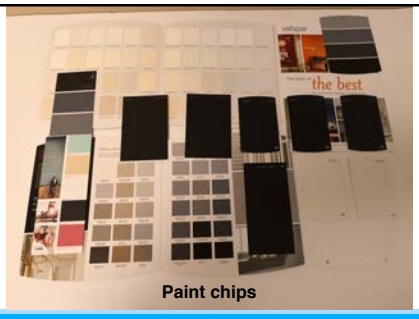
- Experiment configuration
  - *Software*
    - TECHKON SpectroConnect software for measurement data export

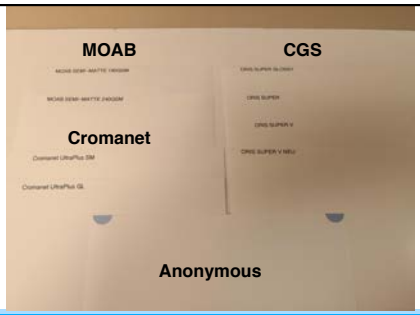
- Experiment configuration
  - *Backing samples*

Type	Black Backing Sample	White Backing Sample	
Leneta Contrast Card	N2C-3 Opacity (Black surface)	N2C-3 Opacity (White surface)	$ 0.07 – $0.35 /sheet
	3NT-1 Ink Test (Black surface)	3NT-1 Ink Test (White surface)	
	3NT- 35 Ink Test (Black surface)	3NT- 35 Ink Test (White surface)	
	3NT-41 Ink Test (Black surface)	3NT-41 Ink Test (White surface)	
	3B – Opacity (Black surface)	3B – Opacity (White surface)	
Munsell substrate	ISO Backer (Black surface)	ISO Backer (White surface)	→ Special request
ChromaChecker	Substrate Inspector Backer (Black surface)	Substrate Inspector Backer (White surface)	→ Not for sale
	Measurement Backer (Black surface)	Measurement Backer (White surface)	→ $ 125 / large, $ 15 / small
Paint chip	Marquee Black G9-7	Valspar Ceiling Paint	$ 22 – $45 / Gal.
	Marquee Limousine Leather MQ5-05	Valspar Woodlawn Dewkist 7004-11	
	Marquee Private Black N530-7 (	Valspar Bleached Slate 7004-20	
	Olympic Black Magic OL116 N6	BEHR Silky White PPU7-12U	
	Sherwin Williams Tricorn Black HGSW1441	BEHR Frost 57U	
	Martha Stewart Silhouette MSL280	BEHR Gallery White PPU12-12U	
	Behr Blackout N510-7	PPG Snow Storm PPG1172-1	
	Glidden Onyx Black GLN62	PPG Commercial White PPG1025-1	
Proofing stock		CGS PearlProof Super	Lunch price varies
		CGS PearlProof Super Glossy	
		CGS PearlProof Super V	
		CGS PearlProof Super V NEU	
		Legion Semi-Matte 195 GSM	
		Legion Semi-Matte 240 GSM	
		Cromanet UltraPlus SM	
		Cromanet UltraPlus GL	
		Anoymous Semi-Matte	









Black Backing

Standard Black Backing

- Standard Black Backing (BB)
  - *Spectrally non-selective.*
  - *Diffusely reflecting*
  - *Opaque* [1]
  - *ISO visual reflection density between 1.30 to 1.60*

Standard Black Backing

- Spectrally non-selective
  - *The total range of spectral diffuse reflection density throughout the wavelength interval from 400nm to 700nm does not exceed 5% of the average density obtained over the same interval*

$$Reflection\ Density(D) = -\log_{10}\left[\sum_{400}^{700}(R \times w) / \sum_{400}^{700} w\right]$$

Where R = Measured reflection value
w = spectral product of Statue T weighted wavelengths

		400	410	420	430	440
2	BB Input 1	0.0335	0.0347	0.0346	0.0328	0.0328
3	BB Input 2	0.036	0.036	0.0357	0.0336	0.0335
4	BB Input 3	0.0364	0.0376	0.0375	0.0347	0.0349
5	Average Reflectance - R	0.0353	0.0361	0.035933	0.0337	0.033733333
6	Spectral product - w (ISO T)	0.000016	0.000019	0.000078	0.000265	0.00061
7	R x w	5.648E-07	6.839E-07	2.8E-06	8.93E-06	2.05773E-05
8	Sum_Rxw	0.034410594				
9	Sum_w	1.000002				
10	Reflection Density	1.463308694				
11	Indiv. D	1.452225295	1.4424928	1.444502	1.47237	1.471940742
12	Range	0.066621158				
13	Avg D.	1.466951947				
14	5% of Avg D.	0.073347597				
15	Pass	1				

Summary | Non-Selective | Reflectance | Gloss | Opacity | Density

Standard Black Backing

- Diffusely reflecting
  - *Little or no perceptible specular reflection when viewed at any angle less than 45° from the normal (ISO 8254-75°* gloss less than 40GU)
  - Note 1 The same tolerance can be used with angles of 60° or 85° as used with inks and coatings.

Standard Black Backing

- Opaque[1]
  - *No clear description from ISO 13655 but ISO 5-4 requires the following:*

d) The backing shall be essentially opaque (one whose own reflection density does not depend on the presence of or type of backing material used in its measurement)

	A	B	C	D	E	F	G
1	*Self backing: sample black surface			*White backing: Leneta N2C-3			
2		Sample					
3	Leneta	**N2C-3 Opacity**					
4		Self backing desnity	1.55	1.57	1.55		
5		White backing densi	1.56	1.57	1.56		
6		WB density Avg.	1.56				
7		**3NT-1 Ink Test**					
8		Self backing desnity	1.26	1.27	1.26		
9		White backing densi	1.24	1.26	1.23		
10		WB density Avg.	1.24				
11		**3NT-35 Ink Test**					

Summary | Non-Selective | Reflectance | Gloss | Opacity | Density

Note: If sample's average WB density is in its self-backing density range, this sample is considered opaque.

Standard Black Backing

- ISO visual reflection density between 1.30 to 1.60

White Backing

Standard White Backing

- Standard White Backing (WB)
  - *Opaque* [2]
  - *Diffusely reflecting*
  - *CIELAB C* value shall not exceed 3*
  - *Non-fluorescing*
  - *Spectral reflectance factor values shall lie within defined range*

Standard White Backing

- Opaque [2]

$$O_B = (Y_b / Y_w) \times 100$$

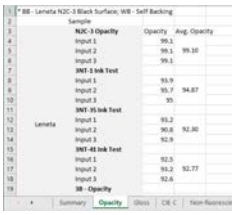
where

O_B is opacity (0°: 45°, D50, 2°, Y) of the backing material

Y_b is the CIE Y value computed from measurements made using black backing

Y_w is the CIE Y value computed from measurements made using a stack of at Least three sheets of the material to be used for backing

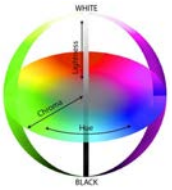
Standard White Backing



BB: Leneta N2C-3
WB: Self backing 3 sheets

Standard White Backing

- CIELAB C* value shall not exceed 3



Standard White Backing

- Non-fluorescing

The Optical Brightening Agent (OBA) are commonly used in papermaking process, which aims to make the paper substrate appears brighter and whiter.

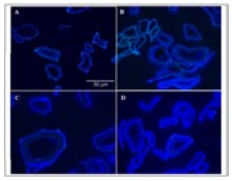
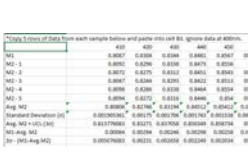


Figure: Fluorescence intensity of paper fiber as a function of OBA change (Reference: Journal of Science & Technology for Forest Products and Processes: VOL. 1, NO. 1, 2011)

Standard White Backing

ISO 13655 states:

"This is equivalent to reading the backing sheet with M1 and M2 modes and the differences at any wavelength greater than 410nm shall be less than or equal to 3σ… of 5 readings of the backing sheet using only the M2 mode"



Standard White Backing

ISO 15397 identified ΔB as a method to represent OBA levels:

ΔB = CIE b* (M1) – CIE b* (M2)

	ΔB < 4	4 < ΔB < 8	8 < ΔB < 14	14 < ΔB
OBA Level	Faint	Low	Moderate	High

Definition:

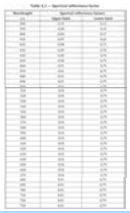
White measurement pad
Opaque (transparency> 99%)
Diffuse reflective
CIELAB C * ≤ 3 (target ≤ 2.4)
No fluorescence (ΔB ≤ 1)
Spectral reflection factors:

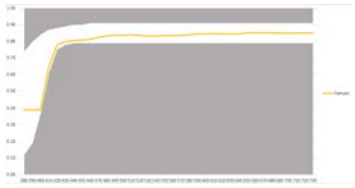
Fogra

No fluorescence (ΔB ≤ 1)

Standard White Backing

- Spectral reflectance factor values shall lie within defined range





Here comes the result…

		Black Backing	White Backing
Type		Sample	Sample
Leneta Contrast Card		N2C-3 Opacity (Black surface)	N2C-3 Opacity (White surface)
		3NT-1 Ink Test (Black surface)	3NT-1 Ink Test (White surface)
		3NT- 35 Ink Test (Black surface)	3NT- 35 Ink Test (White surface)
		3NT-41 Ink Test (Black surface)	3NT-41 Ink Test (White surface)
		3B – Opacity (Black surface)	3B – Opacity (White surface)
Munsell substrate		ISO Backer (Black surface)	ISO Backer (White surface)
ChromaChecker		Substrate Inspector Backer (Black surface)	Substrate Inspector Backer (White surface)
		Measurement Backer (Black surface)	Measurement Backer (White surface)
Paint chip		Marquee Black G9-7	Valspar Ceiling Paint
		Marquee Limousine Leather MQ5-05	Valspar Woodlawn Dewkist 7004-11
		Marquee Private Black N530-7 (	Valspar Bleached Slate 7004-20
		Glympic Black Magic OL116 N6	BEHR Silky White PPU7-12U
		Sherwin Williams Tricorn Black HGSW1441	BEHR Frost 57U
		Martha Stewart Silhouette MSL280	BEHR Gallery White PPU12-12U
		Behr Blackout N510-7	PPG Snow Storm PPG1172-1
		Gliden Onyx Black GLN62	PPG Commercial White PPG1025-1
Proofing stock			CGS PearlProof Super
			CGS PearlProof Super Glossy
			CGS PearlProof Super V
			CGS PearlProof Super V NEU
			Legion Semi-Matte 195 GSM
			Legion Semi-Matte 240 GSM
			Cromanet UltraPlus SM
			Cromanet UltraPlus GL
			Anoymous Semi-Matte

What now?

Understanding the Variance

To understand the variance in opacity measurement when different BB/WB are used, two BB and two WB are selected with three white ink on film with varying pigment load.

- WB: Munsell ISO Backer & ChromaChecker Measurement Backer
- BB: Leneta N2C-3 Contrast Card & ChromaChecker Substrate Inspector
- White ink pigment load: 200%, 100%, 50%

Understanding the Variance

200% ink	100% ink	50% ink
WB_1BB_1	WB_1BB_1	WB_1BB_1
WB_1BB_2	WB_1BB_2	WB_1BB_2
WB_1BB_3	WB_1BB_3	WB_1BB_3
WB_2BB_1	WB_2BB_1	WB_2BB_1
WB_2BB_2	WB_2BB_2	WB_2BB_2
WB_2BB_3	WB_2BB_3	WB_2BB_3
WB_3BB_1	WB_3BB_1	WB_3BB_1
WB_3BB_2	WB_3BB_2	WB_3BB_2
WB_3BB_3	WB_3BB_3	WB_3BB_3

WB_1 – Munsell ISO Backer
WB_2 – ChromaChecker Measurement Backer
WB_3 – BEHR Frost 57U

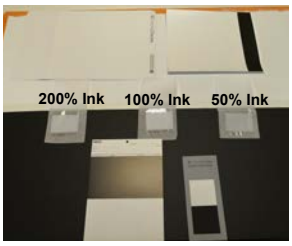
BB_1 – Leneta N2C-3 Contrast Card
BB_2 – ChromaChecker Substrate Inspector
BB_3 – Marquee Limousine Leather MQ5-05

Device: Techkon SpectroDens 4

Subject: Opacity

$$O_B = (Y_b / Y_w) \times 100$$

Understanding the Variance



	200% ink	100% ink	50% ink
Opacity Low	65.93%	56.97%	37.23%
Opacity High	67.07%	58.63%	40.17%
Δ	1.14%	1.66%	2.94%

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- Patrick Brouns – Cromanet

References

- International Organization for Standardization. (2009). *Photography and Graphic technology – Density measurements Part 4: Geometric conditions for reflection density (ISO Standard No. 5-4:2009)*
- International Organization for Standardization. (2017). *Graphic technology – Spectral measurement and colorimetric computation for graphic arts images (ISO Standard No. 13655:2017)*
- International Organization for Standardization. (2014). *Graphic technology – Communication of graphic paper properties (ISO Standard No. 15397:2014)*
- Zhang, Y., Ni, Y., Wong, D., Schmidt, J., Heitner, C., & Jordan, B. (2011). Distribution of Optical Brightening Agent (OBA), in the Fiber Wall of High-yield and Kraft Pulps. *Journal of Science & Technology for Forest Products and Processes: VOL.1, NO.1, 2011*

Please reach out to us for your color projects !!!

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