Colorimetry - Common Color Issues

Metamerism

The colors of two objects appear similar under daylight but different under indoor lighting. This phenomenon, whereby two different colors appear similar under one light source, is called metamerism. For metameric objects, the spectral wavelength of their colors are different but the resulting L*a*b* values are the same under one light source and different under another. This problem arises due to the use of different pigments, dyestuff or materials.

These zippers look similar in shade under Illuminant D65 (Figure 1.1) but does not look the same under Illuminant A (Figure 1.2).

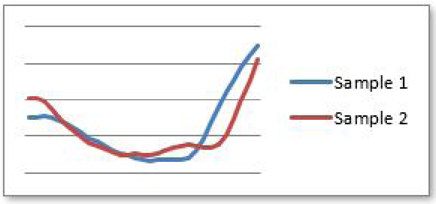
Figure 1.1 - Zipper and Color Sample under Standard Illuminant D65

	Sample 1	Sample 2
L*	38.42	41.45
a*	28.13	24.68
b*	-31.62	-27.21
ΔE*ab	6.36	

Figure 1.2 - Zipper and Color Sample under Standard Illuminant A

	Sample 1	Sample 2
L*	39.17	42.13
a*	23.91	14.99
b*	-28.02	-22.84
ΔE*ab	10.73	

The color for these two samples under Illuminant D65 looks similar however under Illuminant A, it is visually unacceptable. With a metamerism index of 5.53, metamerism can be predicted in advance with a spectrophotometer. The spectral reflectance curves of the two samples intersect each other at three or more points indicating potential metamerism problem.



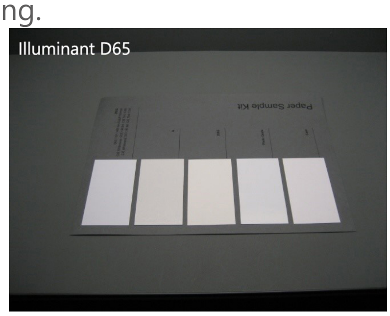
a

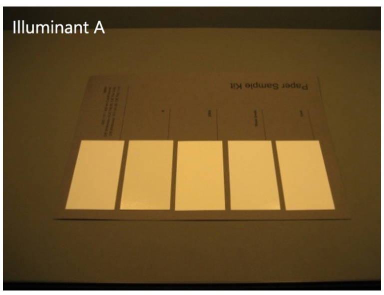
Figure 1.3 - Spectral Reflectance Curve of Sample 1 and Sample 2

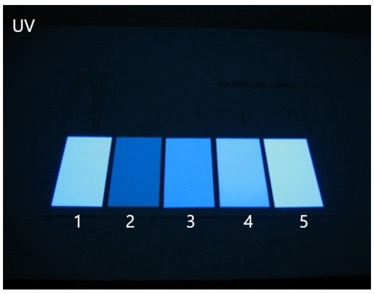
Optical Brightener

Optical brightener agents (OBA) also known as fluorescent whitening agents (FWA) are chemicals designed to brighten color or mask yellowing in fabrics, paper and plastics. OBA or FWA absorbs ultra violet energy and emits light in the blue region to yield a brighter and fresher appearance.

These paper samples showed the effect of white paper with different amounts of OBA under different lighting.







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A test was done on these papers using a Konica Minolta Spectrophotometer CM-2600d to compare the difference with and without UV illumination. The measurement is done based on Illuminant D65 and Specular Component Included condition.

	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5	
	100% UV	UV Cut-off	100% UV	UV Cut-off	100% UV	UV Cut-off	100% UV	UV Cut-off	100% UV	UV Cut-off
L*	93.61	92.63	91.25	91.23	95.73	95.31	95.43	94.81	95.57	94.51
a*	2.64	-0.90	-0.04	-0.28	0.93	-0.33	2.47	-0.64	3.99	0.44
b*	-14.31	-2.95	0.41	1.14	-1.06	2.93	-11.08	-2.27	-13.12	-0.83
ΔE*ab	11.94		0.77		4.21		9.35		12.83	

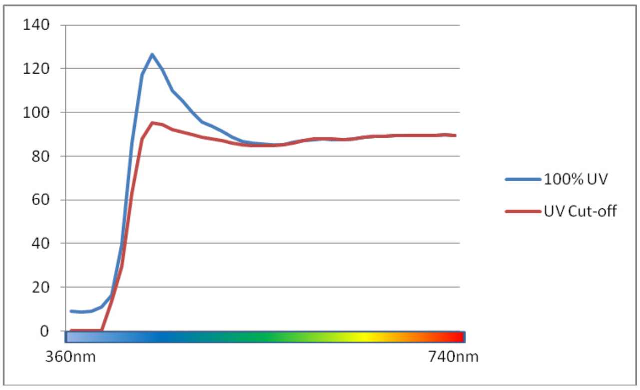

Figure 2.4 - Spectral Reflectance Curve of Sample withUV Cut-off and 100% UV

Sample 2 does not have much influence by UV energy as it contains little or no OBA. It shows a ΔE*ab of 0.77 when comparing the measurement data with and without UV.

Sample 5 glows the most under UV lighting. It gives a ΔE*ab of 12.83 between the UV and non UV effect.

Figure 2.4 shows the spectral reflectance curve of Sample 5 with and without UV.

When there is UV energy, OBA absorbs the UV energy and re-emit in the blue region, making the paper look whiter.

Below are some examples of fluorescent influence in textile. The zipper on the left has fluorescent agent and the color samples on the right do not contain any fluorescent chemicals.

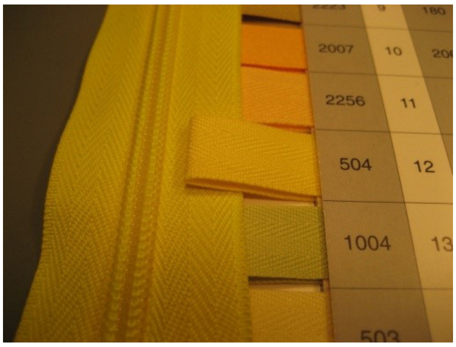

Figure 2.5 - Zippers and Color Samples under Illuminant A

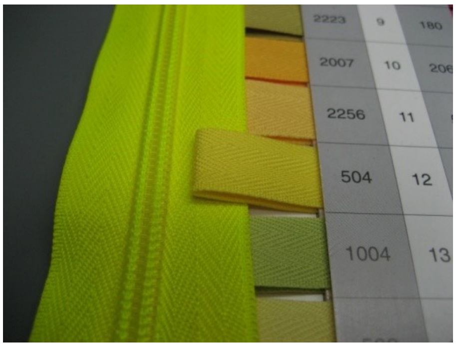

Figure 2.6 - Zippers and Color Samples under Illuminant D65

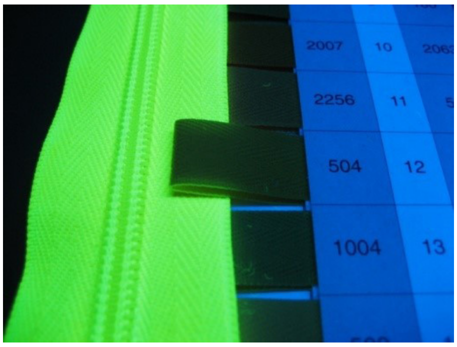

Figure 2.7 - Zippers and Color Samples under UV Light

These zippers contain fluorescence pigments and under Illuminant A, which has no or little UV emission, the color seems close. Changing to Illuminant D65, which has UV emission, the color difference become obvious. Under intense UV light, the zipper glows but the color samples darken as they do not contain fluorescent agents.

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Gloss

Surface texture modifies the way a color appears. A color may look different on different textures.

Figure 3.1 - Glossy Surface versus Matt Surface

When light strikes an object, it reflects at an equal and opposite angle, this is known as the specularly reflected light or specular component. Glossy surfaces have strong specular component.

- The specular component included (SCI) measurement will measure the color with the specular reflected light included.
- Specular component excluded (SCE) measurement does not take the specular component into account.

A measurement is done on the plastic sample shown in Figure 3.2 using both SCI and SCE mode. Area 1 measures the matt surface where Area 2 measures the glossy surface.

	SCI Measurement		SCE Measurement	
	Area 1	Area 2	Area 1	Area 2
L*	25.50	25.41	21.10	16.28
a*	1.13	1.20	1.29	1.99
b*	0.12	0.34	0.04	0.65
ΔE*ab	0.25		4.91	

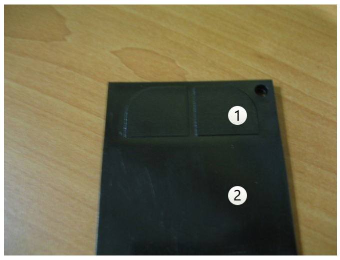

Figure 3.2 - Plastic Resin with 2 Textures Sample

SCI measurement shows that the color of measurement Area 1 and 2 has very little color difference. However in SCE mode, the ΔE*ab goes up to 4.91. The plastic is made from the same resin and color is the same. Due to surface conditions like glossiness, color perception changes.

Solutions To Color Problems

Below are some common color problems the industry faces:

- Non consistency of color between different batches from suppliers.
- Colors of different parts appear different even though supplier is controlling colors.
- Color looks fine by quality inspectors but was rejected by customers.
- Difficulties in communicating colors to customers or suppliers.
- Documentation of color not possible due to poor color fastness.
- Inconsistent lightings making visual perception difficult.
- Conflicts between supply chain due to different perception of color difference.

If you are facing any of the above problems, a color control and management program will help resolves them.

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Color control system consists of instrumentation and documentation. To solve your color problem, choose the correct instrument which fits your requirements.

Here is a checklist in choosing an instrument.

- Do your samples consist of optical brightener or any other UV brightening materials?
- Are you getting parts from different suppliers where there is a risk of metamerism?
- Are you measuring highly textured surfaces?
- Do you need to include or exclude the influence of surface glossiness in your measurement?
- What instrument are your supplier and customer using?
- Do you need to measure small areas?

Derived from our state-of-the-art optical and image processing technologies, Konica Minolta Sensing offers a wide range of color and appearance measuring instruments and solutions that caters to different requirements and needs.

Download our free educational booklets to learn more about the basic of color science.

Alternatively, contact us for a free product demonstration or consultation on how you can improve your color management process and resolve your color issues.