

„Whiter than white“ Color Measurement in the Absence of Colors

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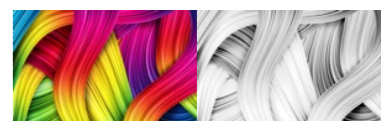


Whiteness?



Is Whiteness the degree to which a surface is white?

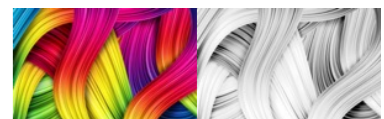
Or is Whiteness the degree to which a surface is perceived as white?



Colorimetry is the science and technology used to quantify and describe the human color perception.

Measuring spectra is comparatively easy - it is much more difficult to reduce the spectra to the physical correlates of color perception.

Examples for such efforts are the Tristimulus values XYZ, the respective color space, the CIE $L^*a^*b^*$ Color space values ...



Even more complex are the definition and measurement of Whiteness...



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... although at first sight it may look simple:

White is the color with

- ◆ the highest LUMINOSITY
- ◆ no SATURATION at all
- ◆ no HUE

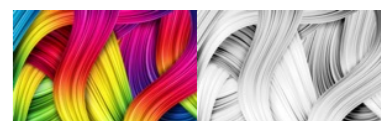


But Whiteness is about perceived White,
i.e. appearing white to the human observer.

Addition of fluorescence:

White > Whiteness,

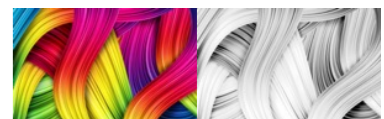
(Stronger psychophysical accent than with other colors)



An observer is not able to distinguish between the physical color White and Whiteness:

Whiteness must be understood as a contraposition of yellow-blue that may be explained with the significance of the limiting colors yellow and blue:

- ◆ Yellow is associated with (negative) properties like old, used, not fresh
- ◆ Blue is associated with coolness, freshness, something new



Whiteness will always be preferred over white, unless the latter shows more luminosity making the former to appear dull.

Each cultural group will set their own standards for the "most beautiful" white.

Some applications may define Whiteness based on the expected alternative (e.g. for paper).

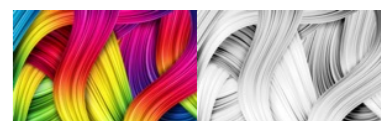


Color White

- ◆ the highest LUMINOSITY
- ◆ no SATURATION at all
- ◆ no HUE

Perceived Whiteness

- ◆ high LUMINOSITY
- ◆ finite SATURATION
- ◆ blue HUE



Whiteness Indexes

acc. to German Wikipedia

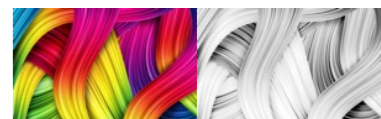
- Berger Whiteness
- Hunter Whiteness
- Ganz Whiteness, Ganz/Griesser Whiteness
- Stensby Whiteness
- Stephanson Whiteness
- CIE Whiteness
- DIN 6167 Yellowness
- ASTM E313 Whiteness
- ASTM D9125 Whiteness
- ISO 2470 Whiteness (Brightness)
- Tappi 525 / R 457 Whiteness
- Taube Whiteness
- CIE Yellowness
- ASTM Yellowness
- L*



Whiteness

acc. to English Wikipedia

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Most Whiteness Indexes developed for specific application.

Example: Paper Quality:

Many Whiteness Indexes describe Whiteness as top quality characteristic as compared to (lower quality) Yellowness.

These Whiteness Indexes are not intended to define or assess general Whiteness.



The International Commission for Illumination
CIE tried a more general approach.

The CIE Whiteness is defined and measured with
D65 illuminant.

The result includes optical brightener effects.

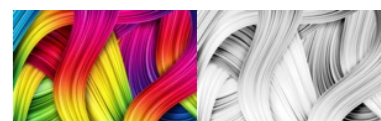
CIE states that this Whiteness measure is suitable
for comparative evaluation (only).

Absolute Whiteness determination may be difficult
due to instruments' differences.



CIE Whiteness:

$$W_{\text{CIE}} = Y + 800(x_n - x) + 1700(y_n - y)$$



Dr. E. Ganz (formerly employee of Ciba AG, Switzerland) belongs to the pioneer group on study of Whiteness, as well as Mr. R. Griesser (formerly employee of J.R. Geigy, Switzerland).

Not only an index but a complete procedure, the Ganz-Griesser method to evaluate Whiteness is currently the only index on the market that takes care of instrument specific factors using a defined calibration scale of fluorescent standards to measure reliable values on different systems.

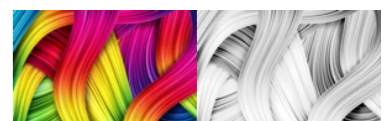


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Ganz/Griesser Whiteness:

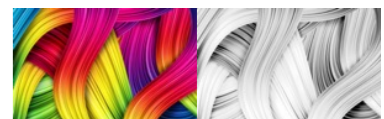
$$W_{\text{Ganz}} = Y - 1868.322 x + -3695.690 y + 1809.441$$



The main difference between these two general Whiteness Indexes for the purpose of evaluating Whiteness of textiles is the between-instruments reproducibility.

Both methods are defined for daylight illumination, i.e. D65 illuminant.

For comparative assessment, both methods appear useful and comparable regarding their results.

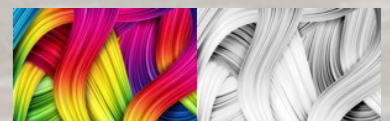


Summary:

- ◆ Whiteness is more than a physical property.
- ◆ Whiteness has psychophysical aspects.
- ◆ Whiteness indexes are intended to reflect the human perception of white surfaces.
- ◆ CIE or Ganz/Griesser Whiteness indexes appear best suited for evaluating the laundry performance aspect of maintaining textile Whiteness.



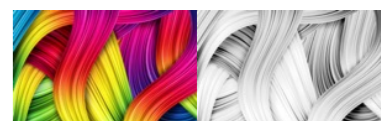
Thank you!



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Test Materials + Concepts





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