

Bringing one of the oldest international standards into the 21st century:

# ISO 5 densitometry

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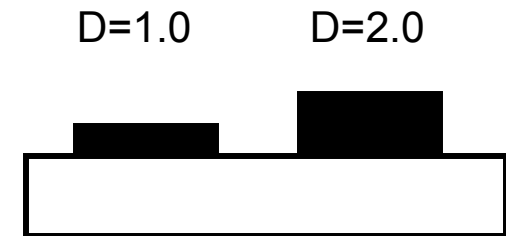
# What is optical density?

Density is essentially log reflectance or transmittance

Density correlates well with the apparent thickness of colorant layers

Densitometry is important for process control in industries where variable-depth colorant layers are applied, especially photography and printing

The ISO 5 series is one of the first ISO standards - indicating the importance of this standard to industry



# What is optical density?

In printing, tonal value in halftone areas is traditionally found by calculating the reflectance of the tint compared to the solid and unprinted areas

$$A = \frac{1 - 10^{-D_t}}{1 - 10^{-D_s}}$$



# What is density?

The reflectance or transmittance is weighted by a spectrally selective function

The role of this function is to shape the density spectrally - usually to maximise the density value of the particular type of colorant

$$D = \log_{10} \left[ \sum_{\lambda} \frac{\Pi_{\lambda} R_{\lambda}}{\text{sum}(\Pi_{\lambda})} \right]$$

where:

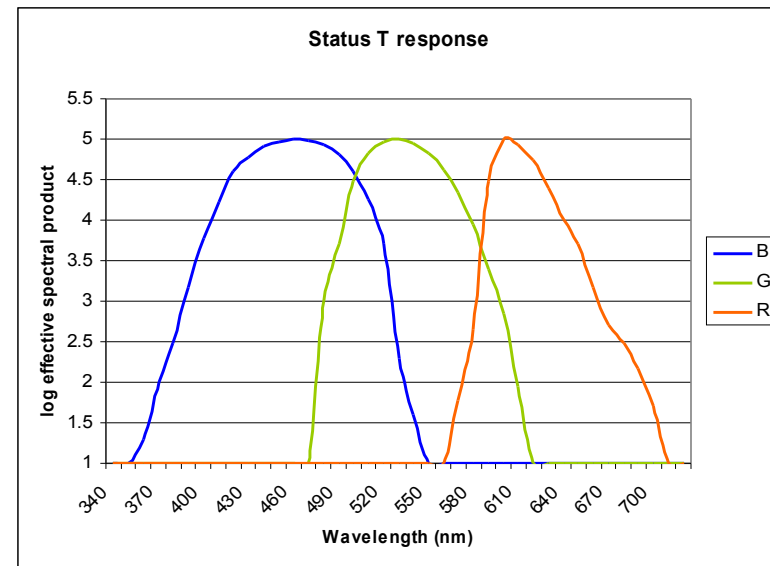
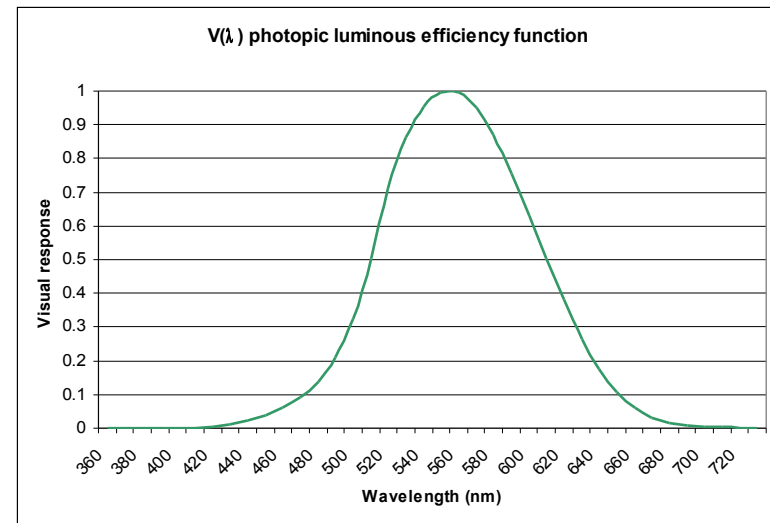
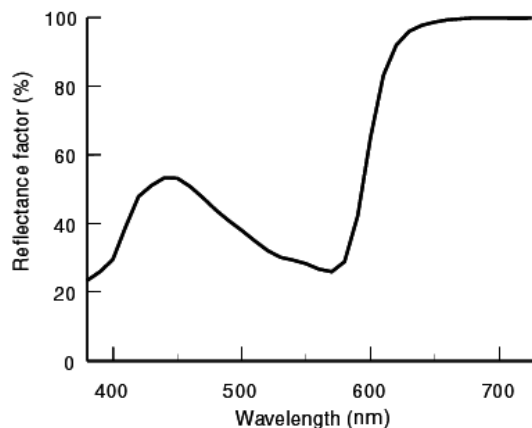
$\Pi_{\lambda}$  is the spectral product at wavelength  $\lambda$  for the given weighting function

$R_{\lambda}$  is the reflectance or transmittance of the sample

# What is density?

ISO Visual weighting function corresponds to the photopic luminous efficiency function

Several 'status' weightings are defined for different types of colorant



# How has densitometry changed?

Densitometry still plays an important role in process control

Traditional densitometers used

- gelatine filters to provide the spectral weighting
- tungsten source to provide the illumination
- analogue electronics

Today's densitometers are essentially spectrophotometers, measuring spectral reflectance or transmittance and computing density from this

They increasingly use semi-conductor sources such as LEDs, which provide better control of spectral influx and reduced heat output

# How has densitometry changed?

Traditional densitometers suffered from a number of problems:

Poor inter-instrument agreement due to differences in effective spectral product, linearity, optics, geometry...

Poor long-term reproducibility due to changes in spectral absorption of filters, changes in the physical characteristics of the light source, instability of calibration materials

A spectrophotometer-based instrument largely eliminates these problems and potentially has excellent inter-instrument agreement making data exchange between sites possible

# Changes in ISO 5

ISO 5 is in revision (joint working group of TC42 and TC130)

The main proposed changes are:

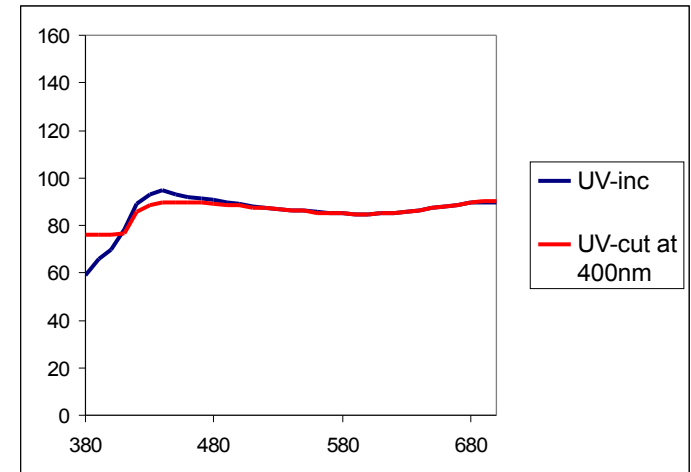
- ❑ Density fundamentally defined as a weighting of spectral reflectance (filters instruments need to match the spectral product)
- ❑ Influx spectrum defined to agree with ISO 13655 (colour measurement) with sources M0 - M3
  - M0: spectral power distribution of Illuminant A (i.e. unfiltered tungsten)
  - M1: spectral power of CIE D50 (300-780nm)
  - M2: any spectral power but with UV excluded
  - M3: any spectral power, with UV excluded and polarization to suppress gloss
- ❑ Geometric specification for reflectance and transmittance tightened



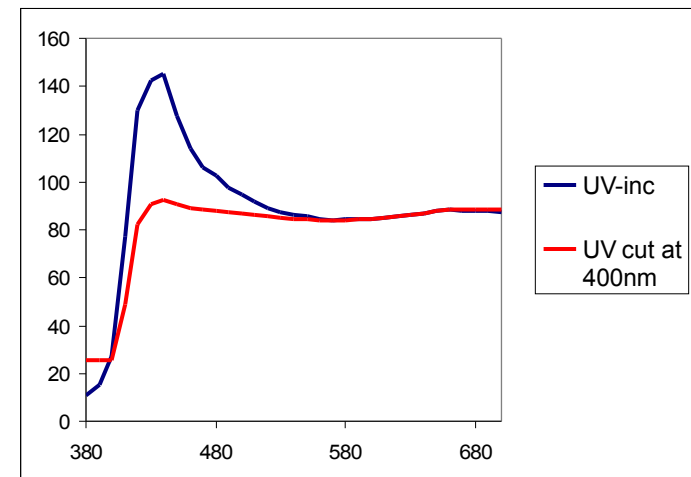
# Issues in densitometry

Some key issues in densitometry (largely addressed in the proposed revision to ISO 5) are:

- Measurement of fluorescent media
- Measurement of wet ink
- Measurement of translucent media
- Choice of filter set



Proofing paper



Production paper

# Conclusions

The revised ISO 5 will provide the basis for inter-instrument

It will support modern technologies for illumination and spectral analysis

It will provide a well-defined basis for handling problem situations such as fluorescent media, wet ink etc

**Thank you!**