



Dyes, optical brightening agents

Permanency of paper and board





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Dyes and optical brightening agents

Dyes are volatile organic compounds that absorb specific ranges of the wavelengths of visible light (400 – 780 nm). Absorption is selective, i.e. only certain wavelengths are absorbed, depending on the compound. The other wavelengths of the irradiated light – which are not absorbed – are reflected from the surface of dyed paper and perceived as the corresponding complementary colour by the observer.

In the paper industry, specific types of dyes are also used for tinting and brightening. Tinting describes a "counterstaining" usually to cover a yellow colouration, e.g. through "blueing". Optical brightening agents on the other hand convert near UV radiation that is not visible to the human eye to visible fluorescence radiation in the violet-blue spectral range (400 to 480 nm). They improve the whiteness of papers in this way.



Fastness of dyes

Selective absorption of dye molecules and fluorescence behaviour of optical brightening agents are both influenced by their molecular structures. Dye molecules contain conjugated double bond systems, which are not very stable to light irradiation and hence generally not "lightfast". Light irradiation causes irreversible changes in the bonding systems and molecular structures. This effect is pronounced when the radiation in the violet-blue (i.e. in the energy-rich range between 400 and 480 nm) is very intensive or characterised by a large UV component. Only a relative assessment of the lightfastness of dyes is possible, such as using the Blue Wool Scale with ratings ranging from 1 – 8: from "very poor" (1) to "excellent" (8).

No dye is however absolutely resistant to light, even if tests specified by the relevant standard (EN ISO 105:2014) give the dye a Blue Wool rating of 8. Also not very lightfast are brightening agents that lose their "whitening effect" relatively quickly under the influence of light. This results in colour changes in originally brightened paper qualities. The colour stability of naturally white paper and board qualities is hence superior to that of optically brightened products.

The updated standard ISO 16245:2012 recommends that paper and board should not contain dyes and pigments if possible. If coloured papers or boards are nevertheless used in conservation, the standard does not require a classification of lightfastness of dyes, but proof of their adequate fixation to the fibre material by means of a bleeding test.

Yellowing

The property of pulps as well as non-ageing resistant paper and board materials to assume a yellow colouration through exposure to light, heat and oxygen is called "yellowing". Causes can be found in the composition of the material, for instance lignin contained in the fibre component or added dyes and/or brightening agents that are not very resistant. Optical brightening agents become ineffective with time, without however affecting the long-term durability of papers. Manifestations of, yellowing through brightening agents are attributable to their decreasing fluorescence, while in the case of dyed paper this is due to structural changes in the dye molecules. The molecular changes progress with the duration of exposure to radiation, so that the observer sees the complementary colour yellow with increasing clarity.



Higher relative humidity accelerates changes in the molecular structure of dyes and hence the development of yellowing.

Passepartout and mounting boards as well as storage folders with dye additives may or may not contain lignin or traces of other components prone to oxidation, if their Kappa number is to lie under 5 in compliance with the standard. If the products additionally fulfil the applicable standard for ageing-resistant paper EN ISO 9706:2010, they must be proven to be ageing-resistant, even if any contained dyes display only limited resistance to light. Their lightfastness will generally be classified within 4–7 on the Wool Scale.

According to the current state of research, colour changes of paper or board, which are due to molecular changes in dyes, are not associated with any effects on the ageing resistance of paper and board. This also applies to ultra-white papers and boards containing optical brightening agents. These are hence not exclusively ruled out as additives in ageing-resistant paper in EN ISO 9706:2010 and/or ISO 16245:2012.

References

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EN ISO 105:2014. T. Textiles – Tests for colour fastness – Part B01: Colour fastness to light: Daylight.

EN ISO 9706:2010. Information and documentation – Paper for documents – Requirements for permanence.

ISO 16245:2012-05. Information and documentation – Boxes, file covers and other enclosures, made from cellulosic materials, for storage of paper and parchment. Berlin: Beuth.

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