Types and Properties of Fluorescent Brightening Agents and Their Application on Textile Industries

By: Senthil Kumar. S

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1. Introduction

Fluorescent brightening agents (FBA) sometimes called optical brightening agent (OBA) or fluorescent whitening agents are fluorescent white dyes that absorb ultraviolet region (340 – 370 nm), light of electromagnetic region emit back visible blue light region (420 – 470 nm). Its suitable for cellulose, nylon, polyester, silk, wool, paper and other polymers. Optical Brightening Agents are 'colourless dyes' which are capable of absorbing invisible ultra violet light and remitting visible 'blue' light

Texlile fibres, detergents, printing paste, polymer, paper, plastics and coatings in the raw state possess aesthetically undesirable creamish cast. The reason of this in case of natural materials is the presence of the natural dyes and pigments and in the case of man-made fibers this is attributable to thermal decomposition. The coloring matter, whether it is natural or present as a contaminant in the fiber is generally decolorized by different bleaching methods. But still they retain a faint, creamy colour. Excessive bleaching can degrade the substrate extremely. Tinting with bluing agents or optical brightening agents can compensate this residual yellowness. Materials treated with these agents appear less yellow. Therefore chemical treatments are become necessary to neutralize the yellow tint of the textile fibers. Optical brightening agents are also used in polymer and cosmetic industries.

Virtually all white fabrics have OBA incorporated or applied during processing. Commercial laundry detergents contain OBA(s) to 'top-up', maintain or increase the level of OBA on the fabric.

1.1. Optical brighteners:

Optical Brightening Agents (OBA‟s) also referred to as Fluorescent Whitening Agents (FWA‟s), are chemicals containing molecules that fluoresce. When they are applied to white materials they give the material the appearance of being “whiter than white.”

1.2. Fluorescence:

Natural daylight is not limited to the wavelengths of the visible spectrum (400 – 700nm). It includes radiation from the entire electromagnetic spectrum including the UV. When radiation of the right wavelength strikes a fluorescent molecule, it excites the molecule and is absorbed by it. As the molecule returns to its previous state, it emits the

absorbed energy as visible light, rather than heat. In the case of OBA‟s, UV energy is absorbed by the molecule and re-emitted in the blue region of the visible spectrum, around 450 nm.

2. Classification of fluorescent brightening agents

The classification of OBA can be either on the chemical structure of the brightener or on its method of application. They can be classified in to two large groups

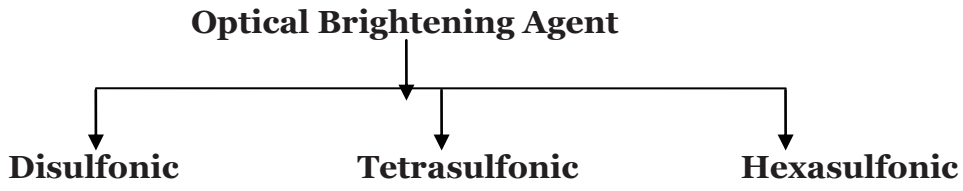

Fig 2.1.Classification of fluorescent brightening agents

2.1. Direct (substantive) brightener

Direct optical brightening agents are predominantly water soluble substance used for the brightening of natural fibers and occasionally for synthetic material such as polyamide.

2.1.1. Tetrasulfonic

It contains four sulfonic groups and has very good solubility they are ideal for cellulosic fiber and paper application at netural for alkaline PH.

2.1.2. Hexasulfonic

It has six sulfonic groups and has excellent solubility for surface coating application like photographic paper.

2.1.2 Disperse brightener

Disperse optical brightening agents are mainly water insoluble and as with disperse dyes they are applied either to colored from an aqueous dispersion on they can be used for mass coloration. They are used for synthetic materials such as polyamide polyester acetate.

2.1.3. Disulfonic

Its contain of two sulfonic acid groups and are suitable for hydrophobic fibers such as nylon, silk and wool application in acidic PH.

2.2. Chemical types of optical brighteners

Most of the OBA compounds contain E- ethylene (-CH= CH-) , E-azomethyne (-N=CH), or carbonyle groups . If they are combined with benzene, naphthalene, pyrene or heteroaromatic rings they can be excited with UV light. In few cases aromatic and heteroaromatic rings can also combined directly, i.e. without one of the three bridging groups.

From the chemical point of view they are classified according to either chemical structure. Chemical optical brightening agents are classified in to derivatives of stilbene, coumarin, 1, 3 diphenyl pyrazoline, derivative of naphthalene dicarboxylic acid, derivatives of heterocyclic dicarboxylic acid, derivatives of cinnamic acid and substance belonging to other chemical system.

Stilbene, is a diarylethene, i.e., a hydrocarbon consisting of a trans ethene double bond substituted with a phenyl group on both carbon atoms of the double bond. The name stilbene was derived from the Greek word stilbos, which means shining.

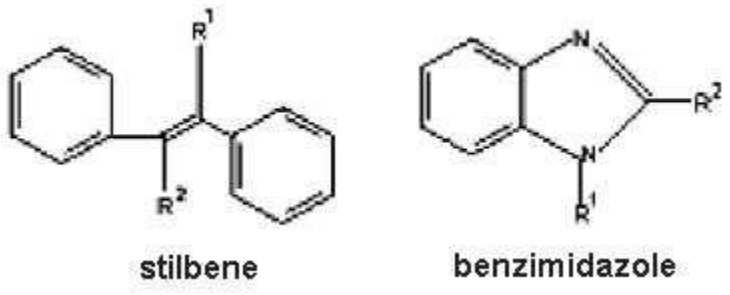

Fig 2.2.1.Structures of Stilbene & Benzimidazole

Finishing agents used in textile wet processing, e.g. chemical compounds optical brightening agents (OBAs) are studies by many researchers. Some researchers reported that the OBAs enhanced cotton fabrics' UV radiation blocking properties. The UV radiation transmittance and UV protection can be affected by OBAs. During the OBAs application process, stilbene or benzimidazole contained in OBAs can provide higher water solubility. Therefore, OBAs can be easily attached to the fibers. The structures of stilbene and benzimidazole are illustrated in Figure.2.

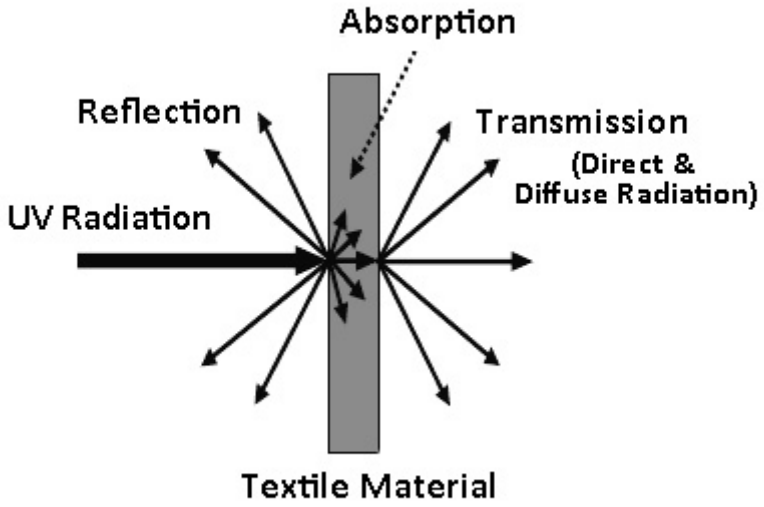

Fig 2.2.1.1.Reflection, Absorption and Transmission of UV Radiation

3. Types of commercial OBA

Table 3.1.Types of commercial OBA and its characteristics

S no	Types (products)	Characteristics and Applications
1	White R C	i. An optical brightener for polyester fibers, very high fastness level, resistant to bleaching baths, bluish-white shade. **ii.** For use in continuous and exhaust processes under HT & LT conditions
2	White R N	i. An optical brightener for polyester fibers, bluish white shade and extremely high fastness level, resistant in all bleaching baths. **ii.** For use in continuous processes at thermosol temperatures of 180° 210° and in exhaust processes under HT conditions.
3	White T 70	i. An optical brightener for polyester fibers, neutral to bluish-white shades. ii. For use in continuous and exhaust processes under HT & NT conditions. **iii.** Very good general fastness properties, for use in peroxide bleaching baths.
		i. Optical brightener for polyester fibers, brilliant, bluish-white shade.

4	White R Supra	ii.	For use in continuous and exhaust process under HT conditions.

S no	Types (products)	Colour index (C I)	Application
1	Onewhite 2B(Powder)	24	Paper / Textiles
2	Onewhite OPS (Powder)	28	Detergent
3	Onewhite DMX (Powder)	71	Detergent / Textiles
4	Onewhite BA (Powder)	113	Textiles
5	Onewhite Bal (Liquid)	113	Textiles
6	Onewhite NYR(Liquid)	134	Textiles
7	Onewhite UP (Liquid)	154	Paper / Textiles
8	Onewhite KPL (Powder)	184	Plastic / PVC / PP
9	Onewhite GRE (Powder)	185	Textiles
10	Onewhite SI (Liquid)	220	Paper / Textiles
11	Onewhite WHN (Powder)	253	Textiles
12	Onewhite MST (Liquid)	253	Textiles
13	Onewhite BMF (Liquid)	263	Textiles
14	Onewhite DT (Powder)	351	Detergent / Textiles
15	Onewhite PLS (Powder)	393	Plastic / PVC / PP

4. Mode of action of optical brightening agents

Optical brightening agents when present on the textile materials, show fluorescence. They absorb invisible ultra–violet light and emit radiation in the visible range at blue to violet end of the spectrum. The absorption maximum lies in between 300 to 400 nm. The wavelength of the emitted radiation lies between 400 to 440nm. They lower reflectance in the UV region by absorbing radiation and increase the same in the visible region by emission. They act as supplementary emission source. At atomic level the fluorescence phenomena involves the emission of radiation from the lowest vibrational level of the excited singlet state S1 to any of the vibrational levels of the ground state. At high concentration of optical brightening agent the fluorescent reflectance is too large for human eye to receive a white impression. Such a sample appears to be very bright, but it has a bluish shade. In no case they can replace cleaning / scouring and bleaching.

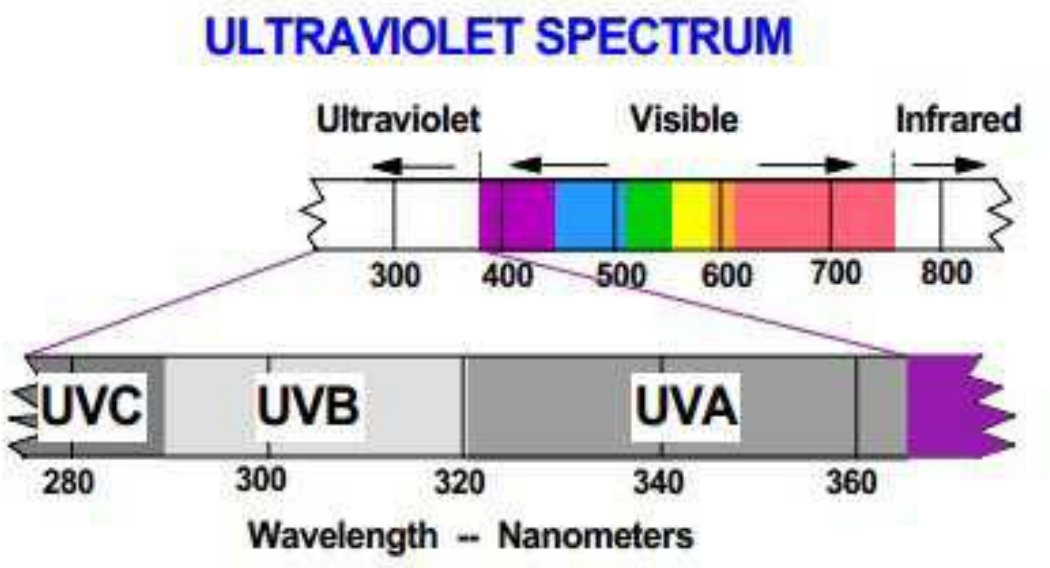

Fig 4.1.The electromagnetic spectrum

5. Whiteness Measurement

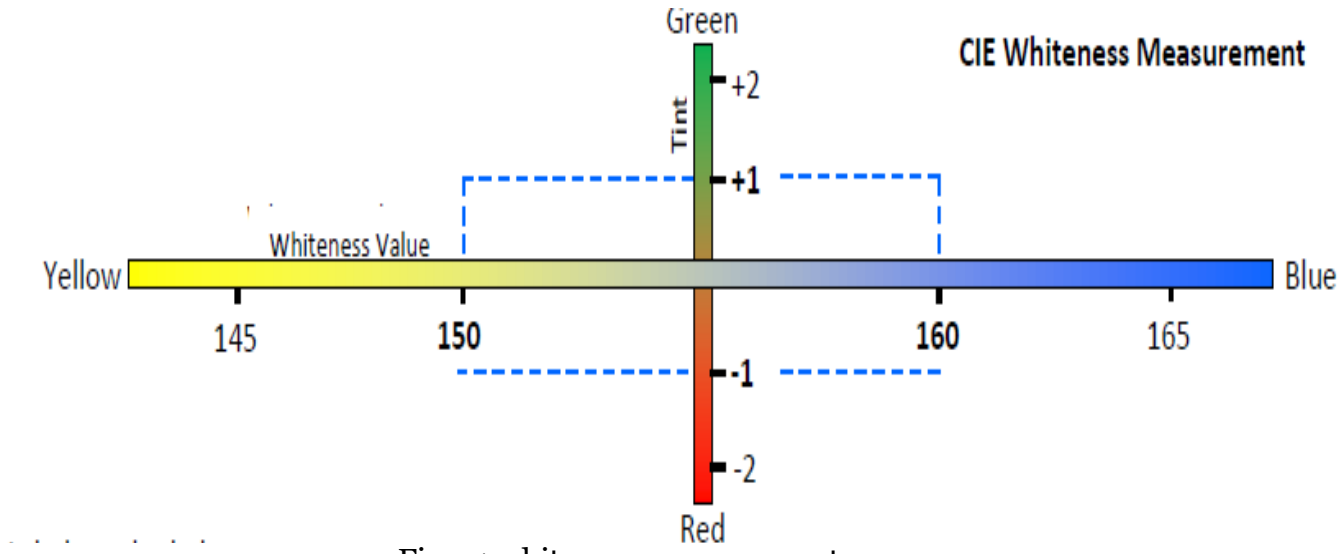

Fig 5.1.whiteness measurement

$$W_{CIE} = y + 800(x0 + x) + 1700(y0 - y)$$

and

$$T_{CIE} = 900(x0 - x) - 650(y0 - y)$$

Where,

$(x0, y0)$ Are the coordinate of the achromatic point for the given illuminate.

The values of the coefficients are valid for $D_{65}/10^{o}$ condition. However the formula has been used also with other illuminants.

- (dw/ds) is assigned a value for 1700
- Tint >0: white has a greenish shade
- Tint <0: white has a reddish shade

The formula is quite widespread and has been adopted by many standardizing institution like ISO, AATCC, ASTM, DIN & etc.

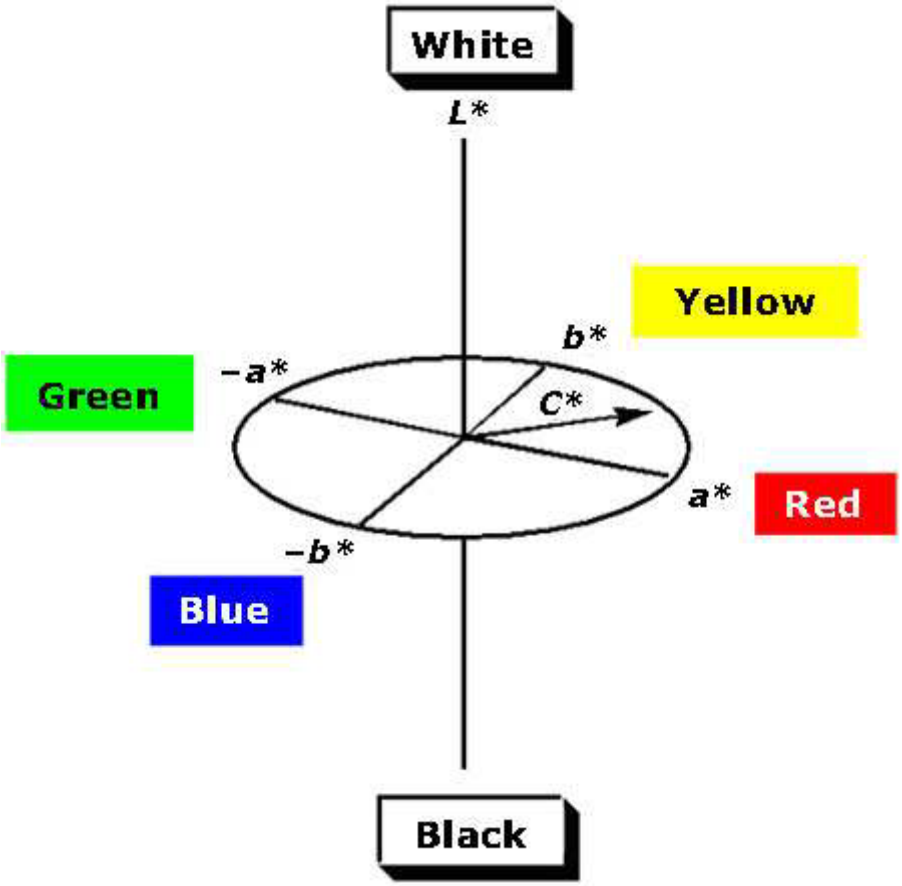

Fig 5.3. CIELAB color space

In addition to color lightness (L*), color redness/greenness (a*) and yellow/blueness (b*) in relation to fabric UPF value were investigated. Color redness/greenness and yellow/blueness of a fabric can be affected by different types of dyes and OBAs, colors and concentrations. In CIELAB measurement, a* values represent the color redness/greenness and b* values represent the color yellowness/blueness. The color axes a* and b* run from positive to negative and have no numerical limit. +a* represent red color while –a* represent green color. Besides, +b* represent yellow color while –b* represent blue color. For both a* and b* axes, neutral color gray is zero.

6. Properties of Fluorescent Whitening Agents for Textiles Use

Before selecting an optical brightener for textile application we must look for following properties,

1. It should have good solubility, should not have its own color and good substantively for the textile substrate under OBA application.
2. OBA's should have good light as well as wet fastness properties.
3. Its rate of strike on the substrate.
4. Build up and exhaustion properties.
5. Requirement of electrolytes and its sensitivity towards different exhausting agents.
6. Effect of temperature on the exhaustion and build up properties.

7. Application pH range and sensitivity towards change in pH.
8. Effect of water hardness.
9. It should have good leveling and penetrating properties.
10. Should not decompose to colored products on exposure to atmospheric conditions as well as storage, and it should not absorb light in the visible region.
11. It should be compatible and stable with finishing chemicals, auxiliary and process such as heat and temperature.
12. It should be stable and fast to the common oxidative and reductive bleaching chemicals and bleaching systems.

8. Conclusion

The main function of OBAs has been widely used for fabric whitening in the textile industry. Untreated grey fabric heaving yellow surface and its contains impurities. In the olden days bleaching was used to manage whiteness and these problems. Nowadays whiteness of a fabric can be enhanced by the application of OBAs. Increasing the concentration of OBAs on the fabric it could increase the colour brightness and which would eventually enhance the fabric ultra violet protection factors values. Some researchers reported that the OBA enhanced cotton fabric heaving UV radiation blocking properties. New products (OBA) are live extremely essential role in the achievement of white. Bec ause poor white and asthmatics may spoil very high quality of fabrics.

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