High Light Fastness Digital Printing of Textiles

Digital Technical Textile Printing for Automotive and Outdoor Furnishings

David Clark
Huntsman Textile Effects

Products Requiring Very High Light Fastness

- **Automotive**
  - Primarily polyester due to fiber durability
  - Currently either solution and exhaust dyed and screen printed with high energy disperse dyes
  - “Just-In-Time” manufacturing
  - Limited print design flexibility currently

- **Outdoor Furnishings**
  - Primarily polyester and acrylic
  - Currently solution dyed or screen printed with pigments
  - Limited design and supply chain flexibility as a result
Light Fastness on Polyester Textiles Explained

- Color fading and textile damage is caused by a small amount of the sun’s energy called UV radiation.
- UV accounts for only 2% of the sun’s energy but accounts for 70% of the damage.
- Polyester fibers are very resistant to abrasion, weathering and sunlight however current technologies used to digitally print it do not match fiber performance.
- Chemical structure of the disperse dyes and use of UV absorbers is critical to performance.

General Introduction

- Visible light spectrum runs from Red to Violet.
- Red light longest, violet light shortest.
- Light shorter than 400 nm is called ultra violet (UV).
- Light longer than 700 nm is called infra red (IR).

How does this impact color performance on polyester textiles?
**Color Fading Scale 1-5 According To End Use**

1 – Apparel/fashion fabrics

2 – Indoor signage/sportswear

3 – Indoor textiles (curtains) - protected by window glass (to some extent) and exposed to sunlight a few hours per day

4 – Automotive Textiles – exposed to longer times in sunlight and to temperature

5 – Outdoor textiles (awnings, sun umbrellas) are exposed to direct sunlight worst condition for fading and fiber degradation

Only 1 & 2 (and some 3) can be printed successfully with standard sublimation inks.

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**Outdoor Fabrics – Polyester**

**How do I rate the Performance?**

Service Life
6 months – 7 years

Outdoor Accelerated
3 months – 2 years

Laboratory Accelerated
100 hours – 2500 hours
1 week to 15 weeks
Factors Influencing Light Fastness

- Fastness Test Method
- Fabric Factors
- Ink – Type and Energy Level
- UV Absorber
- Finishing Chemicals
- Fabric Processing

Which Test Method Do I Use?

- Automotive Interior, several methods
- AATCC 169-3
- SAE J1885
- SAE J1960
- B62 “South Africa”
- AATCC 16-3
- South Florida
- ISO 4892-2A1
- B102 Eu-normal
- AATCC 16E
- B04 Xenon-weathering \( \frac{1}{2} \) – \( \frac{1}{2} \)

320nm 310nm 290nm 280nm
UV light

More Energy

100°C
80°C
65°C
50°C
Temp

More Energy
Fastness Tests

Table of the most common light fastness test methods

<table>
<thead>
<tr>
<th>Method</th>
<th>ISO 105 B02 (Europe)</th>
<th>AATCC 16E (USA)</th>
<th>Toyota TS L9900 met.1</th>
<th>Art. Weathering ISO 4892-2A</th>
<th>FAKRA VDA 75202</th>
<th>SAE J 1885 (USA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irradiance</td>
<td>1.6 W/m² (420nm)</td>
<td>1.2 W/m² (420nm)</td>
<td>0.68 W/m² (420nm)</td>
<td>1.2-1.3 (420nm)</td>
<td>0.55 W/m² (420nm)</td>
<td></td>
</tr>
<tr>
<td>Black standard temperature</td>
<td>~ 48 °C</td>
<td>---</td>
<td>65 °C</td>
<td>100 °C</td>
<td>ca. 95 °C</td>
<td></td>
</tr>
<tr>
<td>Black panel temperature</td>
<td>45 °C</td>
<td>63 °C</td>
<td>89 °C</td>
<td>45 °C</td>
<td>ca. 92-96 °C</td>
<td></td>
</tr>
<tr>
<td>Test chamber temperature</td>
<td>31-34 °C</td>
<td>43 °C</td>
<td>62 °C</td>
<td>35-38 °C</td>
<td>65 °C</td>
<td></td>
</tr>
<tr>
<td>Rel. Humidity</td>
<td>~ 50 %</td>
<td>30 %</td>
<td>~ 50 %</td>
<td>65 %</td>
<td>~ 20 %</td>
<td></td>
</tr>
<tr>
<td>Exposure conditions</td>
<td>matches conditions behind glass</td>
<td>matches conditions behind glass</td>
<td>matches to wet outdoor conditions</td>
<td>more UV than behind glass, less than outdoor</td>
<td>more UV than behind glass, less than outdoor</td>
<td>substantially more UV than outdoor</td>
</tr>
<tr>
<td>approx. UV limit (1% of irradiance at 420nm)</td>
<td>310-315 nm</td>
<td>300-305 nm</td>
<td>310-315 nm</td>
<td>290-295 nm</td>
<td>300-305 nm</td>
<td>280-285 nm</td>
</tr>
</tbody>
</table>

Today’s PES Ink of Choice - Sublimation

- Most widely used textile ink today
- Low molecular weight
- Easy to apply via transfer paper
- Acceptable color fastness on
  - Indoor banners
  - Apparel and sportswear
- Not suitable for more technical textile applications
  - Poor light fastness properties
  - Off tone color fading
  - Low heat stability
  - Poor weatherability fastness
Why not use pigments on PES?

- Restricted coloristic properties, no «pop» effect
- Restricted crocking / rub fastness
- Poor/no fiber penetration
- Poor abrasion resistance (automotive)
- Binder-containing inks tend to be more difficult to jet

Applications limited more to non-contact PES end-uses

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High Energy Disperse Inks

- Larger molecule, differentiated chemistry
- Particles diffuse into PES fibers during thermofixation or steaming
- More difficult to process than sublimation inks
- Exhibit excellent color fastness properties
  - High light fastness (UV)
  - On-tone fading (very important)
  - High heat resistance – non-migrating
  - Excellent weatherability fastness
  - Respond more to UV absorbers.
## Fastness Test Comparison

**FAKRA (Hot Light)**

Automotive interior

Test conditions: Temperature 65°C / Humidity 20% / more UV light / one cycle 72 h

<table>
<thead>
<tr>
<th>Sublimation</th>
<th>High Energy Disperse</th>
<th>Sublimation</th>
<th>High Energy Disperse</th>
<th>Grey Scale</th>
</tr>
</thead>
</table>

Target: 4

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## Fabric Factors

**SUBSTRATE FACTORS THAT INFLUENCE LIGHT FASTNESS**

<table>
<thead>
<tr>
<th>untexturized</th>
<th>TEXTURE</th>
<th>texturized</th>
</tr>
</thead>
<tbody>
<tr>
<td>bright</td>
<td>DELUSTRANT</td>
<td>full dull</td>
</tr>
<tr>
<td>coarse</td>
<td>DENIER</td>
<td>fine</td>
</tr>
<tr>
<td>round</td>
<td>FIBER FORM</td>
<td>multilobal</td>
</tr>
</tbody>
</table>

**positive** | **negative**
UV ABSORBERS

MODE OF ACTION OF UV ABSORBERS AND FIBER STABILIZERS

- Reduces the amount of UV light absorbed by dye chromophores
- Deactivates the excited states of dyes
- Acts as anti-oxidant
- Scavenges free radicals

Marked Effect of UV Absorber

AATCC Method 16-3 @ 1000 Hours

W/O UV Absorber

With UV Absorber
Chemicals That Affect Light Fastness

- Oils and sizes can have a negative effect on light fastness. It’s important that the fabric be clean before pretreatment.
- Some of the components of the ink can also degrade light fastness. A post-scour after fixation is highly recommended for optimum results.
- Certain chemical finishes can have a negative effect on light fastness. These include:
  - Softeners
  - Flame retardants
  - Polymeric coatings
  - Cationic treatments

Summary

- Durability, color fastness, meeting brand specifications and application know-how are essential to drive market growth in the automotive and outdoor segments.
- Machines are already developed to print fabrics for these end use applications.
- Process control and knowing your substrate are keys to meeting very high durability specifications.
- Brands & retailers will play an important role in the market conversion specifying digital print and building new business models.