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Photochromism

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The course is developed under Erasmus+ Program Key Action 2:
Cooperation for innovation and the exchange of good practices Knowledge Alliance

ICT IN TEXTILE AND CLOTHING HIGHER EDUCATION AND BUSINESS

Project Nr. 612248-EPP-1-2019-1-BG-EPPKA2-KA

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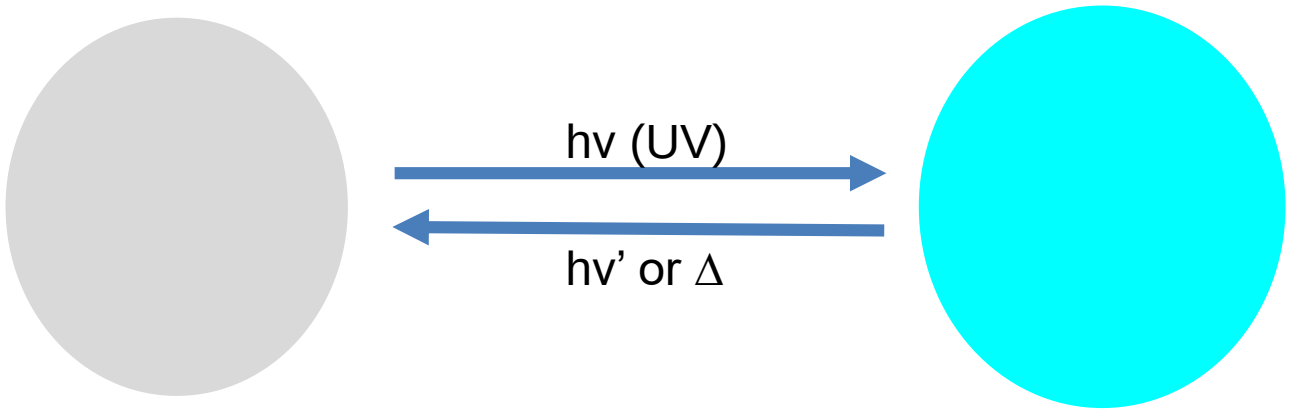
1. Definition

- **Photochromism = Photo**(light) + **Chrom**(colour) + **ism**(phenomenon)

- A light-induced reversible transformation of a chemical species between two states having different absorption spectra[1]

- A reversible conversion of a chemical species between two isomeric forms triggered by electromagnetic radiation absorption, resulting in color changes[2]



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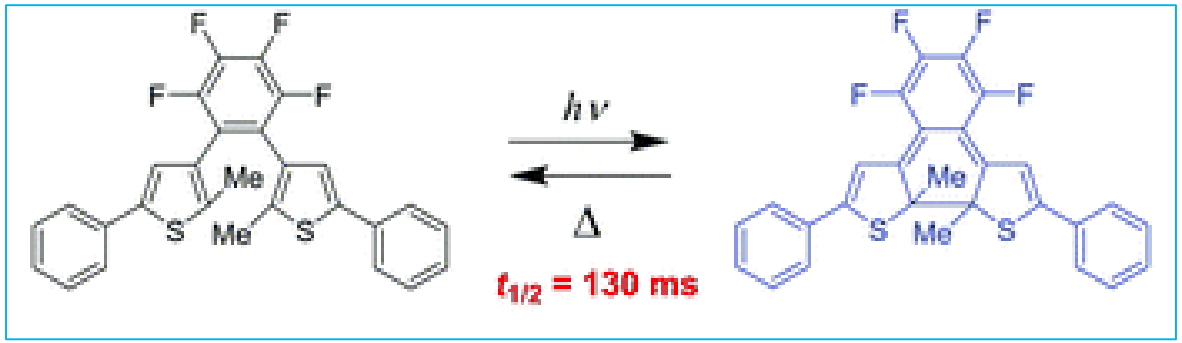
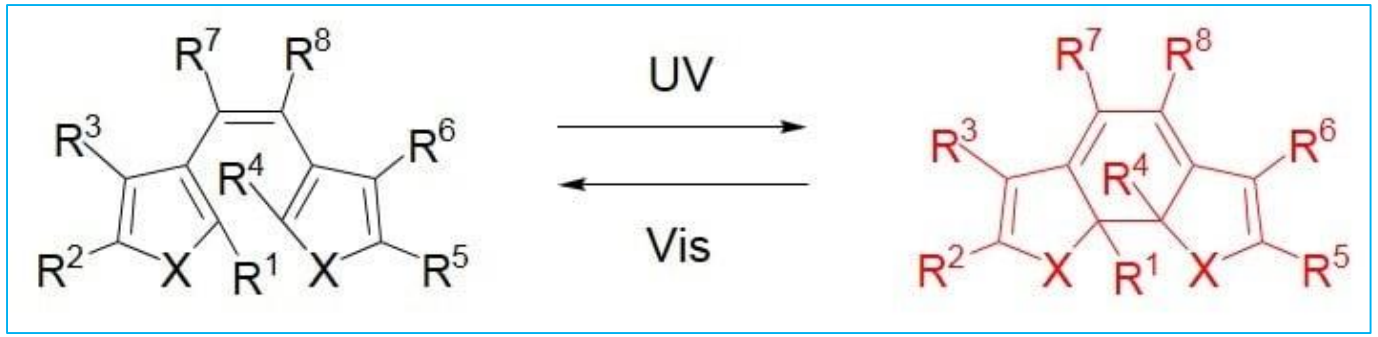
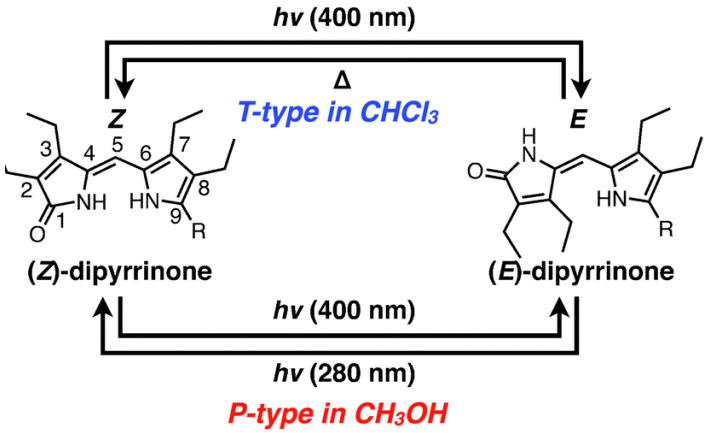
2. Modes of Photochromism

Three modes of photochromism

- T-type[1]
- P-type[2]
- Dual mode[3]







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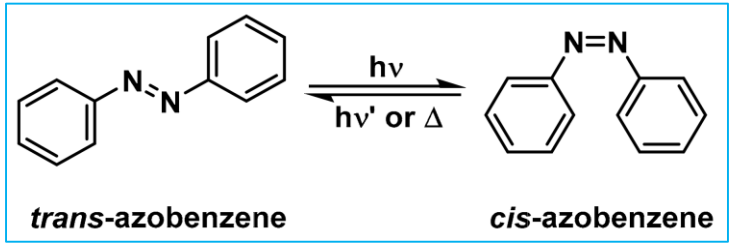
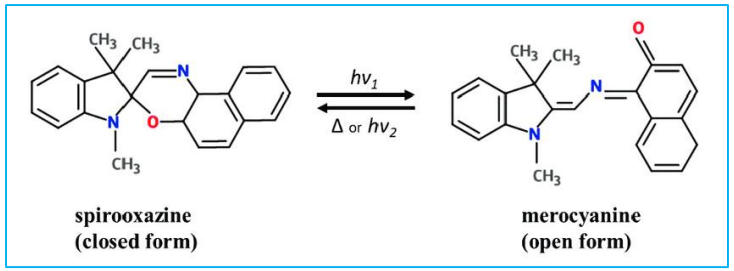
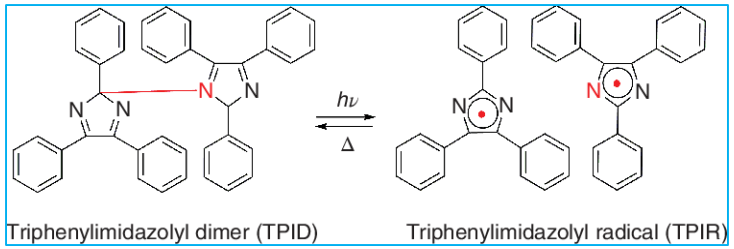
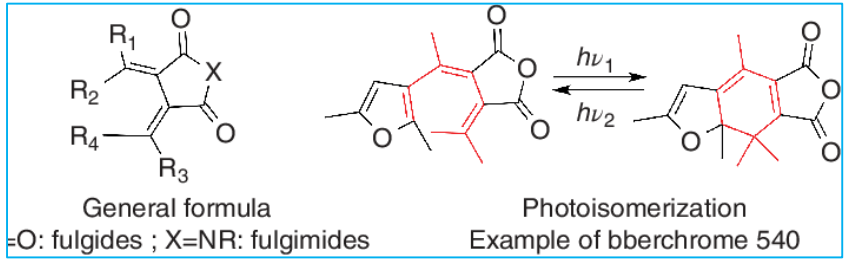
3. Photochromic Molecules

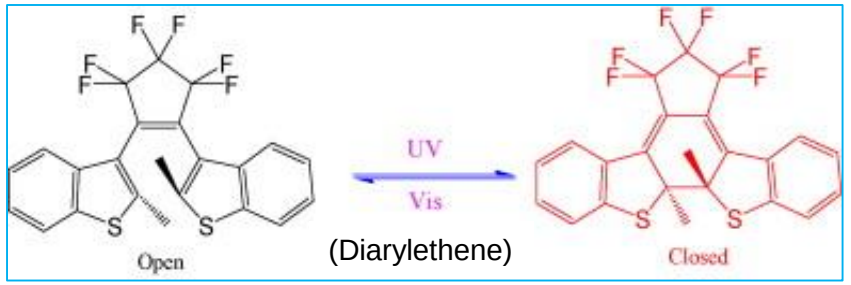






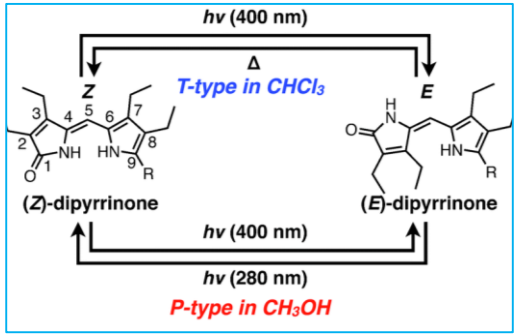
T-type

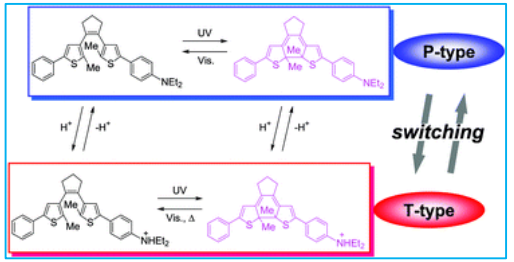




(Diarylethene)

P-type





Dual mode

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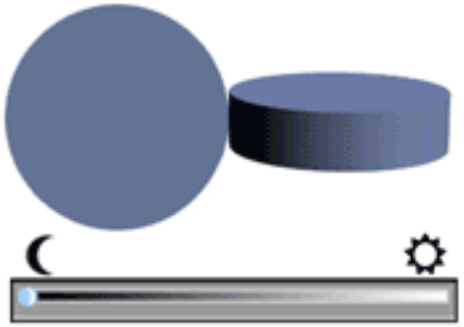
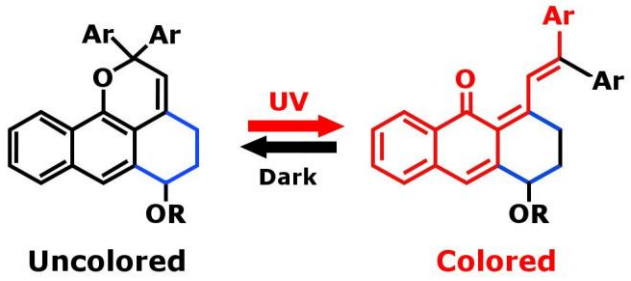
4. Mechanisms of Photochromism

Upon the action of UV light or direct sunlight, the structure twists from a perpendicular (closed) form to a flat, planar (opened) structure. This allows the two halves to interact, resulting in the absorption of visible light.



There are effectively two changes occurring simultaneously;

- Chemical change[1]
- Structural change[2]



It is a fully reversible reaction[3]

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..... Mechanisms of Photochromism

Photochromic reactions have several mechanisms;

- Cis - trans isomerization
- Triplet - triplet photochromism
- Tautomerism photochromism
- Homolytic fission
- Heterolytic fission
- Fotodimerization

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5. Photochromic Substrates

- Substrate which exhibit increased light absorption when they are exposed to light[1]
- Can be made of;
  - Glass
  - Plastic
  - Textile

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6. Fabrication of Photochromic Substrates

- The addition of a photochromic substance to a transparent material usually results in photochromic properties.
- Photochromic substance can be photochromic molecule containing;
  - ✓Inks
  - ✓Dyes or pigments

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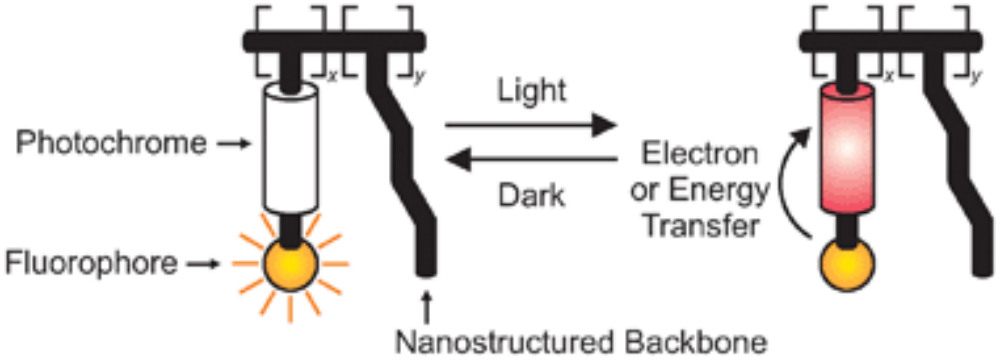
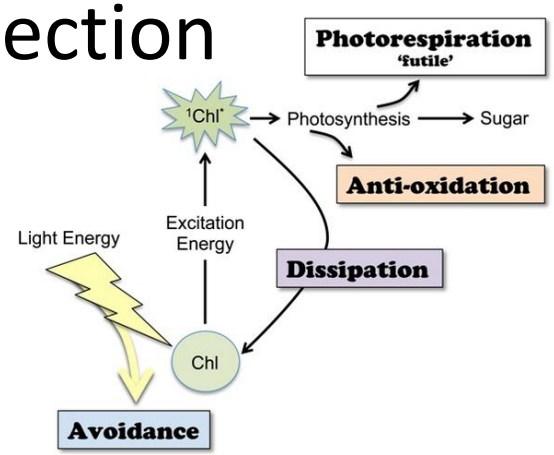
7. Functions of Photochromic Substrates

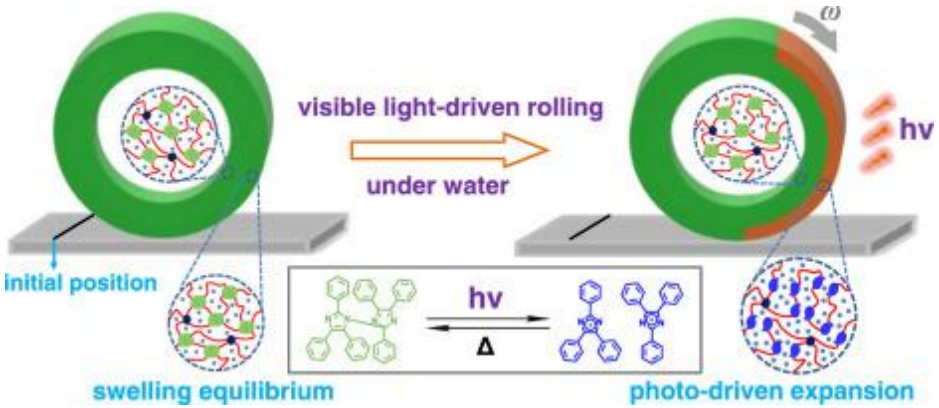
- Photo-memories
- Photo-switches
- Photo-driven actuators
- Photo-protection



https://doi.org/10.1039/B804151M



https://www.nature.com/photoprotection



https://doi.org/10.1016/j.nanoen.2021.105965

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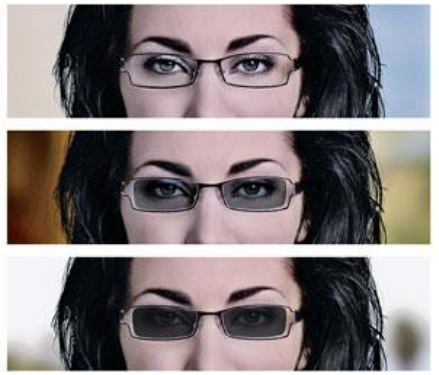
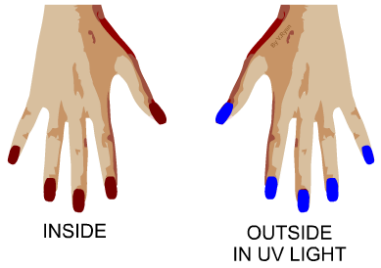
8. End Uses of Photochromic Substrates

- Photochromic storage
- Lenses and responsive eyewear
- Photochromic window
- Decorative paintwork
- Rewritable paper
- **Photochromic textiles**

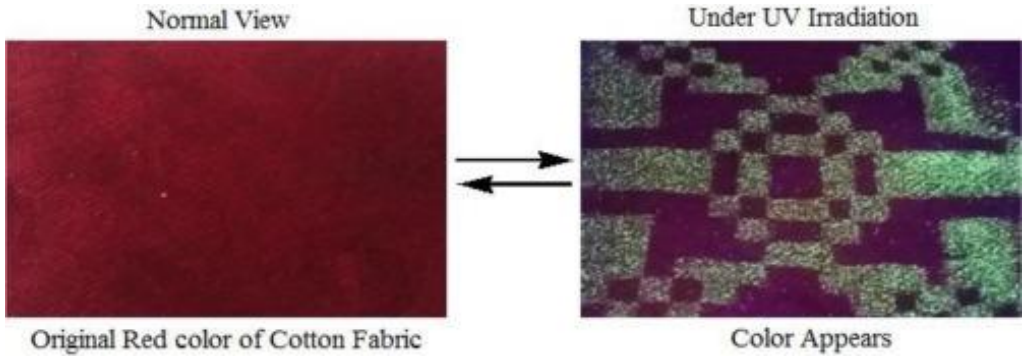




https://www.amazon.com/HOHOFILM-X20-Photochromic-Window-Film/dp/B07SRRF667

9. Photochromic Textiles

- Among the smart textile products, can reversibly change their color during exposure to light[1]
- Can be a fiber, yarn[2], fabric[3] or ready made garment



https://photoluminescent.en.made-in-china.com/product/LNKEOsqlSBVp/China-Photochromic-Pigment-for-Yarn-Making-Ultraviolet-UV-Photosensitive-Color-Yarn.html

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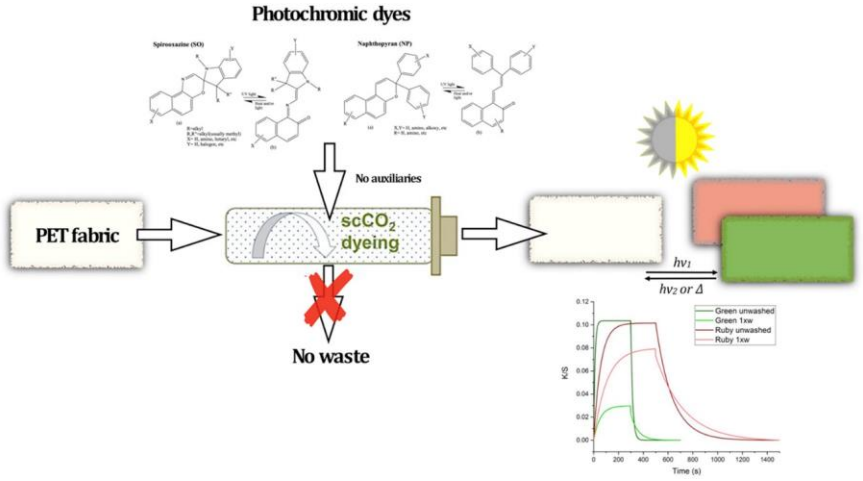
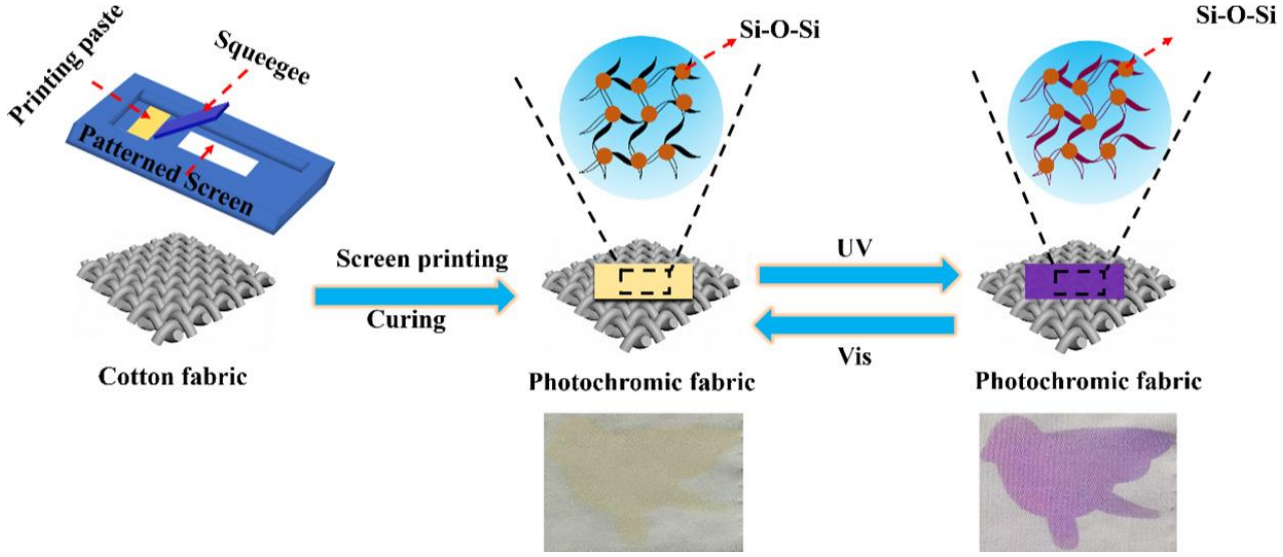
9.1. Fabrication Methods of Photochromic Textiles

- Dyeing
- Printing
- Sol-gel coating[3]
- Mass coloration[4]



Supercritical CO_2 dyeing of polyester fabric with photochromic dyes to fabricate UV sensing smart textiles[1]



Screen-printed photochromic textiles with high fastness prepared by self-adhesive polymer latex particles[2]

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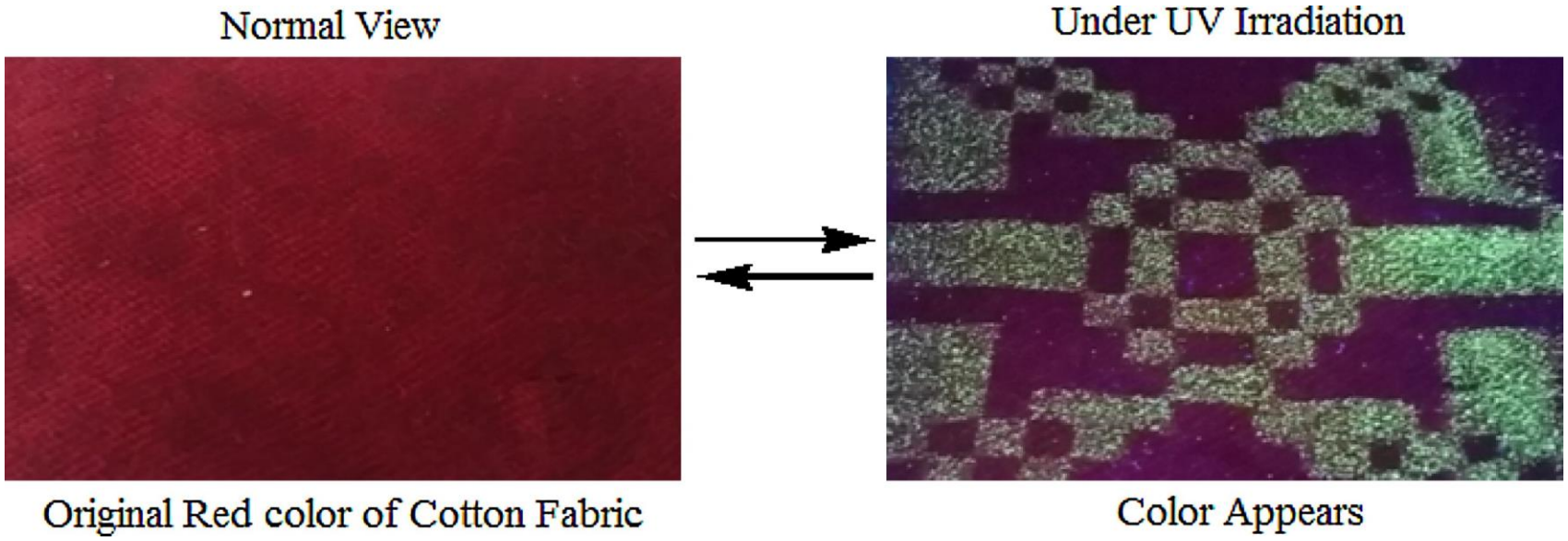
9.2. End Uses of Photochromic Textiles

- Sensors and Display
- UV Protection
- Energy harvesting and dye-sensitized solar cells
- Fashion and Entertainment
- Camouflage military clothing
- Reflective warning and safety vests
- Smart light stabilizing curtains

….. End Uses of Photochromic Textiles … e.g.

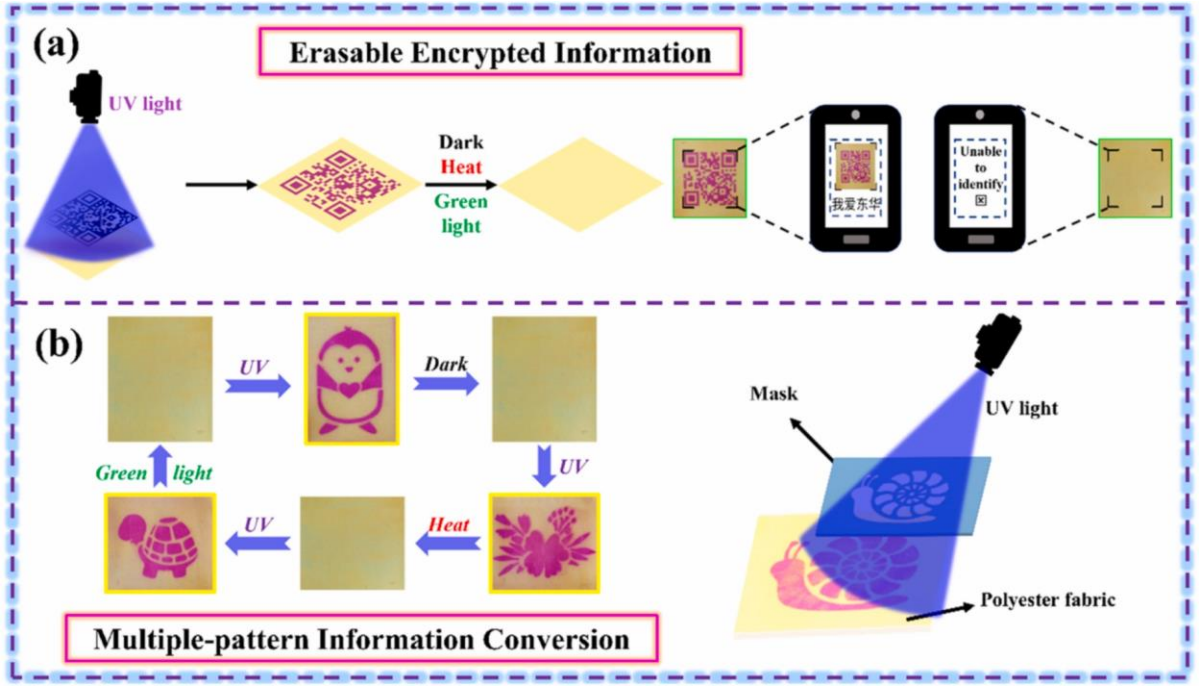
- UV Protection



Cellulosic fabric printed with strontium aluminate pigment showed UV protection[1]

….. End Uses of Photochromic Textiles … e.g.

- Energy harvesting and dye-sensitized solar cells



Smart screen-printed photochromic polyester fabrics for energy and information storage applications[1]

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….. End Uses of Photochromic Textiles … e.g.

- Fashion and Entertainment

Rainbow reflective fabric: reflective textile reflex based on printing reflective powder or coating reflective film on the surface of normal textile fabric, once light switches on, the fabric reflects[1]

….. End Uses of Photochromic Textiles … e.g.

- Smart Curtains
  - ✓ The utility model discloses the fabric of a photochromic curtain
  - ✓ Made of photochromic coated weft and warp yarns
  - ✓ Shields the sunlight

https://patents.google.com/patent/CN202187137U/en

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10. Summary

- Photochromism is the reversible transformation of a chemical species between two states with different absorption spectra caused by light.
- Photochromic textile materials can be used for photo sensing, memory, protection, actuation, energy harvesting, color changing, and other applications.
- Photochromic textiles can be created by incorporating photochromic inks, dyes, and pigments into conventional textiles using **conventional textile production and finishing methods**.

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