PHOTONIC TEXTILES: OVERVIEW OF THE TECHNOLOGY, APPLICATIONS AND COMMERCIALISATION OPPORTUNITIES

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http://xslabs.net/karma-chameleon/index.php

What are photonic textiles?

Flexible textile substrate
with
light emission or light manipulation functionalities

Textile coatings

- Multilayer flakes (Spectraflair) and films
- Holographic films
- Phosphorescent films
- Thermochomic and photochromic inks
- Retroreflective ink

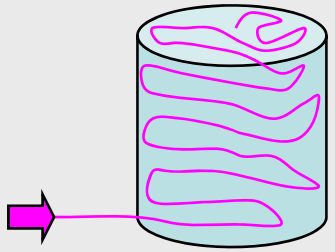
Light emitting elements

- Fluorescent fibers
- Electroluminescent wires and sheets
- LED’s
- Optical fibers (Total Internal Reflection)
- Photonic Bandgap fibers

Photonic textile applications

Mechanically flexible technology for large area illumination, distributed sensing, information transmission, and fashion

Photonic textiles enable



Illumination

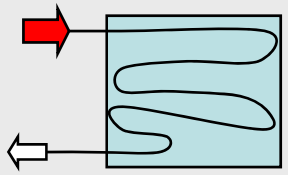
1. Practically unlimited coverage area and complex shapes
2. Apparel with unusual or/and dynamically addressable appearance
3. Fiber-based illuminators can be used not only in the visible (~500nm) but also in the IR (invisible) ranges (1-10μm) for security and military applications

Sensing (optical fiber-based)

1. Distributed sensing (T, P, …) over 1m-1km X 1m-1km areas without any point sensors
2. Electrically passive technology, ability to operate in flammable environment
3. Textiles can be easily integrated into large scale structures such as bridges, houses, etc. for long term structural integrity monitoring with minimal servicing requirements.

Communication

1. Integration of the fiber optic communication links into uniforms



Enabling technologies for the light manipulation

- **Multilayer flakes and films**

highly reflective colorful appearance, textile perception depends on the angle of observation

- **Holographic films**

highly reflective colorful appearance , textile perception depend on the angle of observation, 3D images and more complex visual effects than in Mult. films

- **Phosphorescent films**

'light batteries', glow in the dark

- **Thermochromic and photochromic inks**

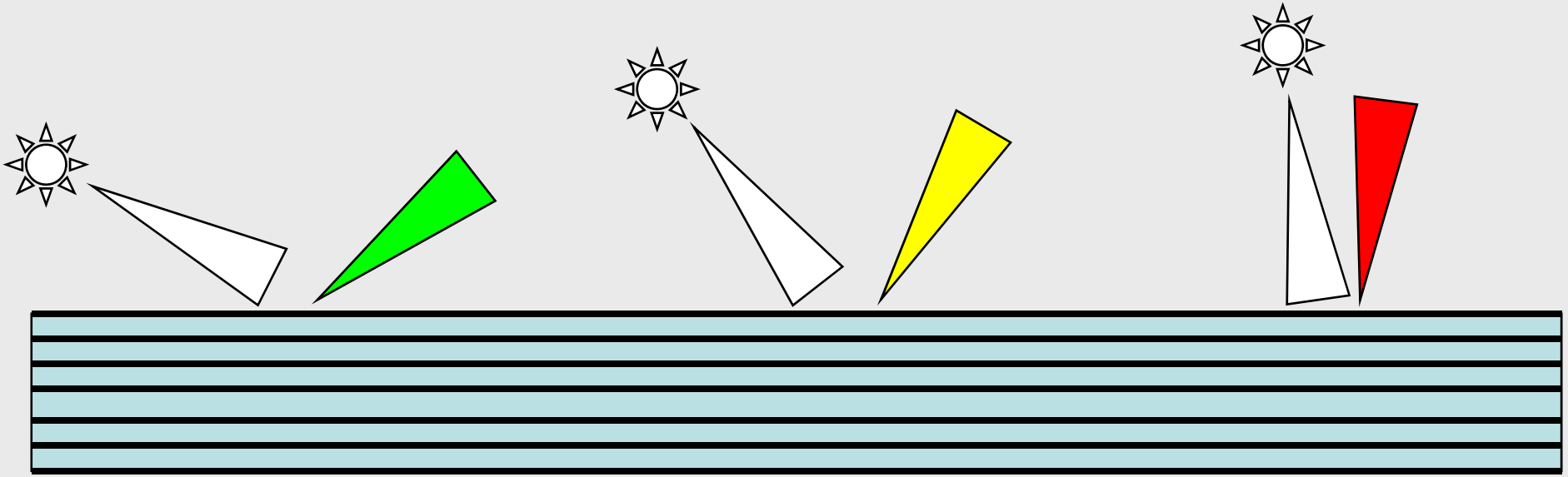
textile color appears or disappears in reaction to heat or light

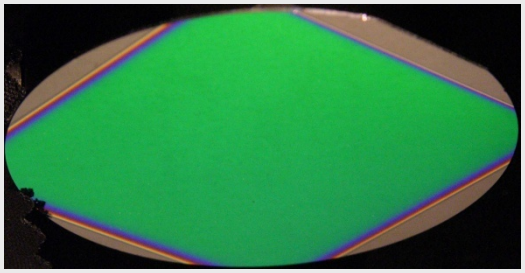
- **Retro reflective ink**

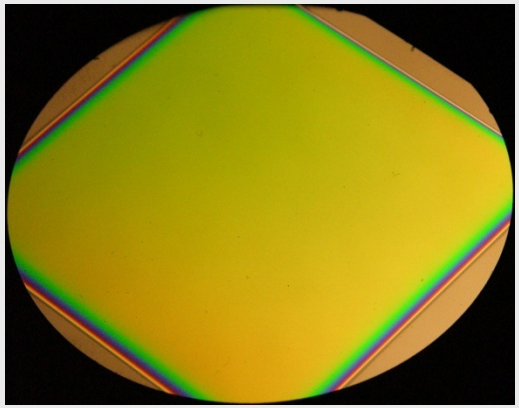
highly reflective appearance, reflection is directed towards the source, worker's safety ware

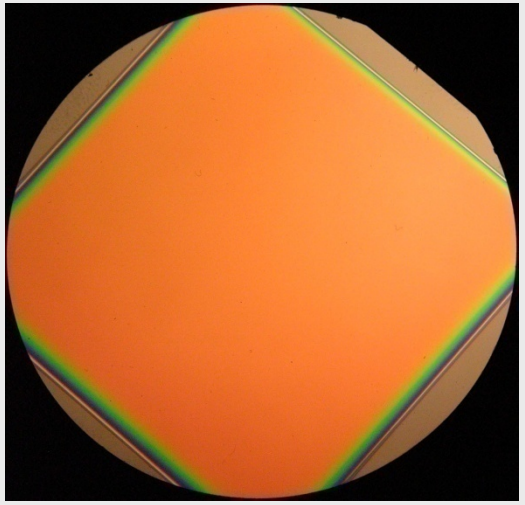
Multilayer films

Dielectric multilayer “mirrors” reflect different colors when looked at different angles





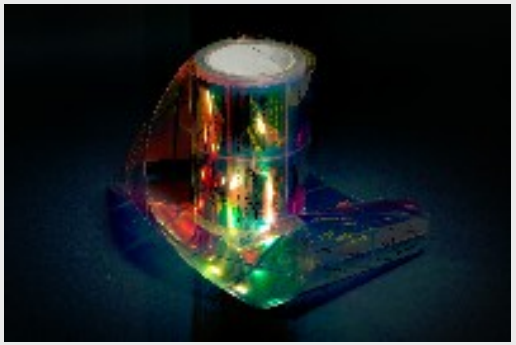




Multilayer films

3M™ Radiant Light Films

These films provide a dazzling array of colour to enhance and bring to life any product packaging. When laminated to a white or coloured background, Radiant Films offer an almost endless array of colour options.



Under normal lighting

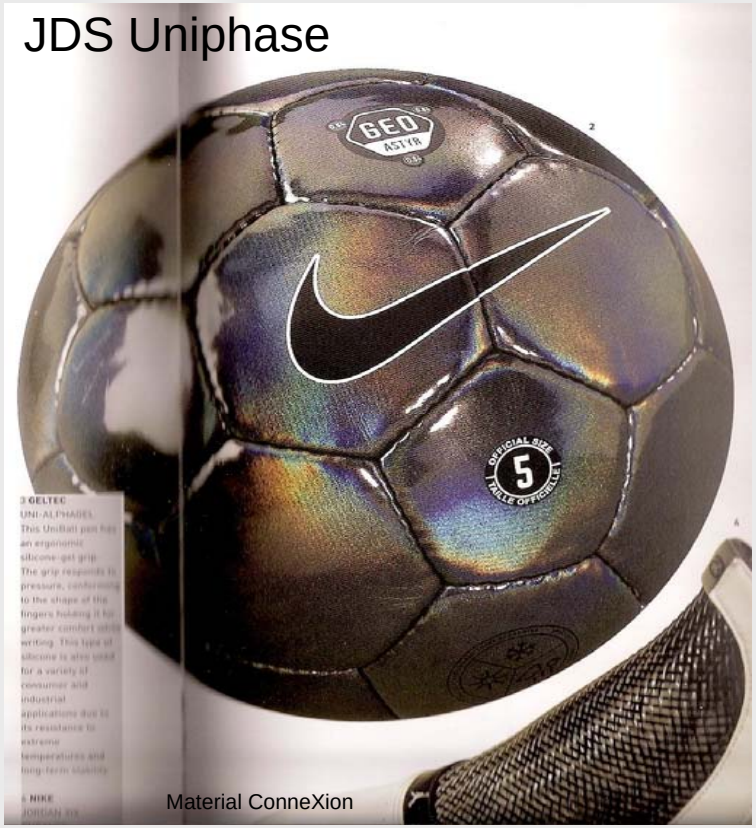
Under artificial lighting

Multilayer flakes (pigments)

Nike
SpectraFlair pigment

This pigment is a specialized diffractive colorant for automotive and industrial coatings that show multiple rainbow colors as the viewing angle changes. It is based on microscopic aluminum flakes layered with glass and inorganic pigments.

The combination of SpectraFlair's rainbow-like color, aluminum core, and fine particle size creates an iridescent, liquid silver metallic appearance.

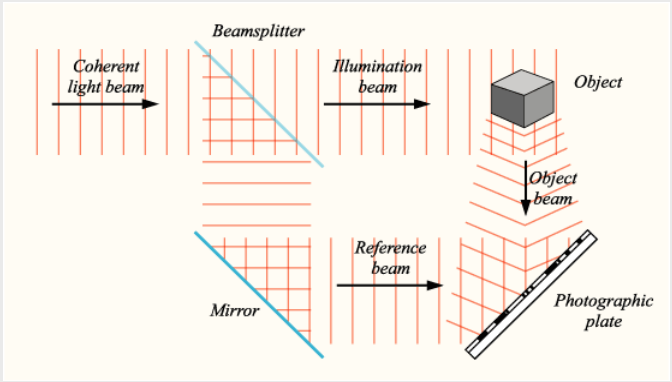


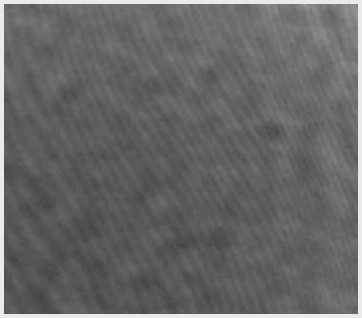
Holographic films

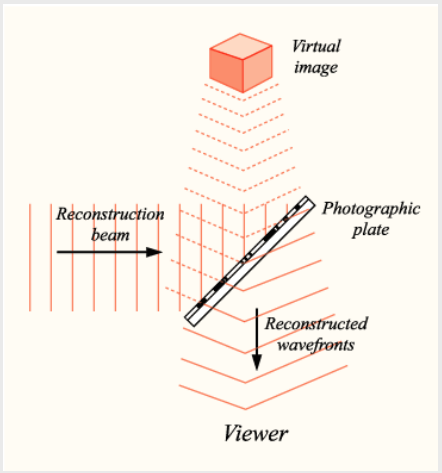
Holographic film

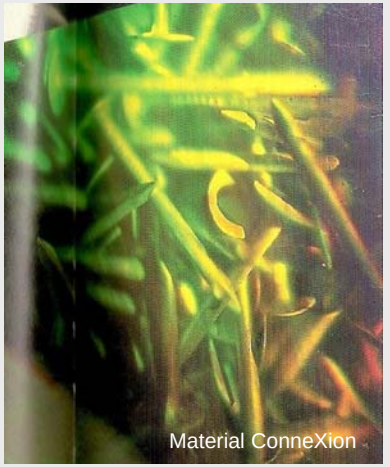
This is a very thin, flexible plastic film, which have been micro-embossed with a holographic image or pattern. The embossing process creates a pattern or an image which can provide a 3-D effect and spectral coloring.

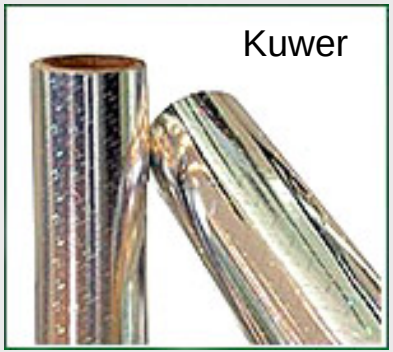
The film can be laminated to different types of materials for various packaging applications. They can also be laminated to paper or card stock to make consumer packaging and specialty gift boxes and bags.









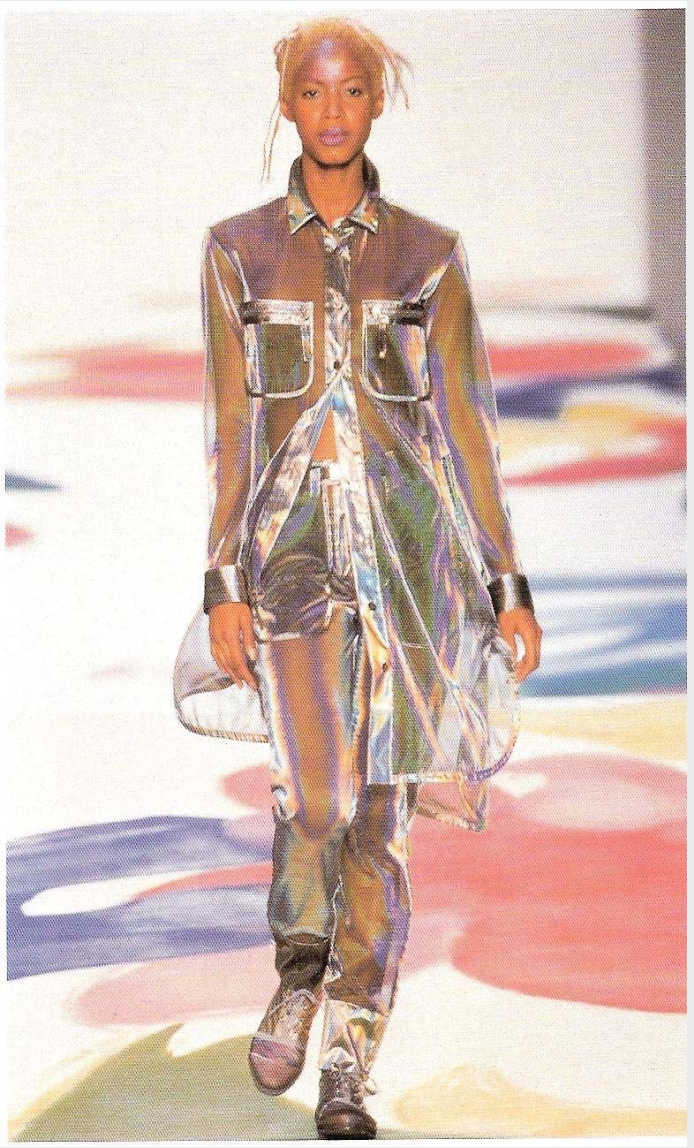


Holographic films

Issey Miyake
Holographic jacket and trousers 1996

These jacket and trousers are made from monofilament polyamide with a holographic finish.

The transparent fabric shimmers against the skin, contrasting with the solid holographic used on the collar, pockets and cuffs. This is not only a technically excellent project but also playful and fun, common themes in the work of this designer.



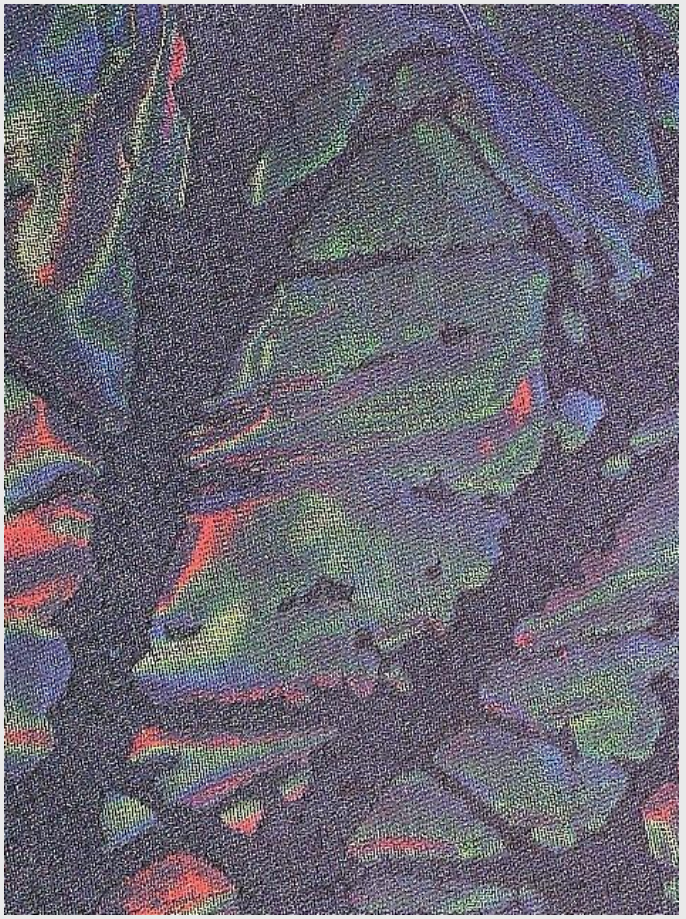
Techno Textiles, S.E. Braddock et al., Thames & Hudson

Holographic films

Helen Archer
Aster Universal Ltd
Cactus 1995

This fabric is produced using spray enhanced polyester and Holofoil.

A dévoré fabric works with a holographic foil and transforms into an amazing surface with light reflecting properties.



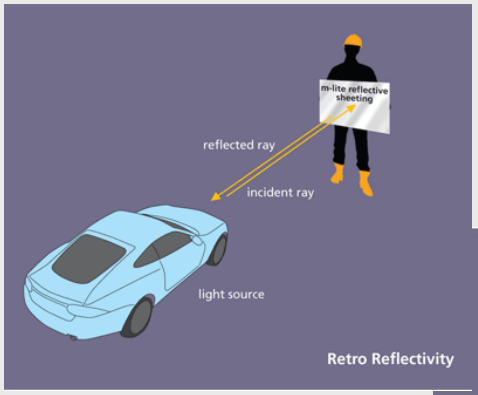
Techno Textiles, S.E. Braddock et al., Thames & Hudson

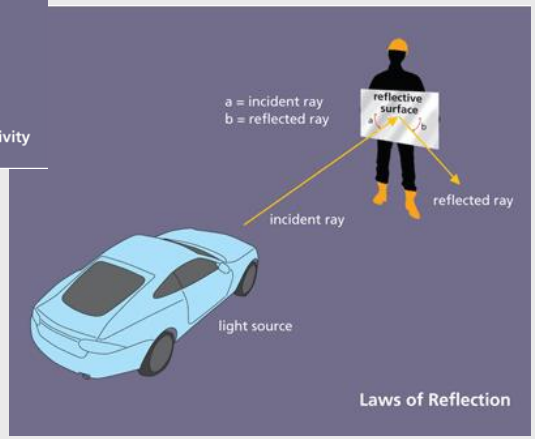
Retro reflective inks

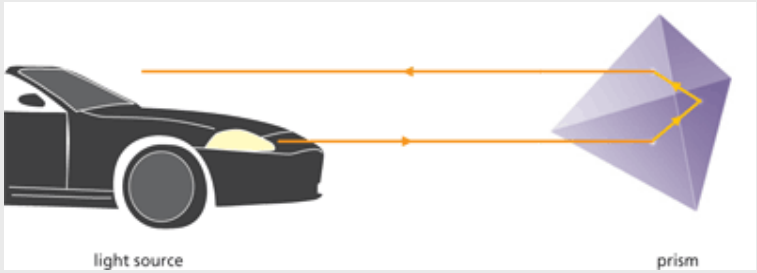
Retro reflective

A reflection is the return of a wave from a surface that it strikes into the medium through which it has travelled. Generally, the objects are visible because of the light reflected from their surfaces.

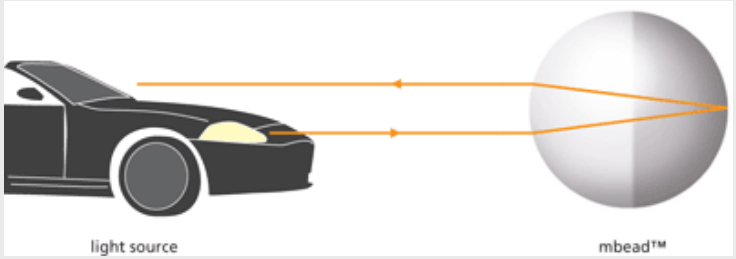
www.vizreflectives.com







three mutually perpendicular mirrors which form a corner. (Often referred to as a prismatic material)



reflecting and refracting optical elements arranged so that the focal surface of the refractive element coincides with the reflective surface, typically a transparent sphere and a spherical mirror.

Retro reflective tapes and fabrics

Retro reflective inks, tapes and fabrics

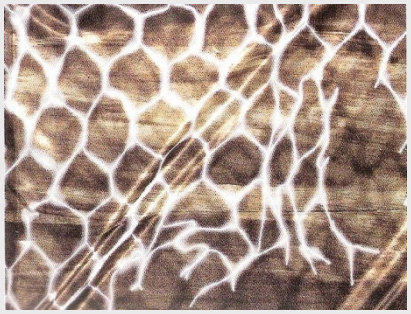
Retro reflective properties are usually created by coating a fabric with tiny glass beads.
The beads reflect the incoming light from its original source. Retro reflective textiles are extensively used in safety, sports and work wear.

http://www.swicofil.com/innovationretroreflective.html

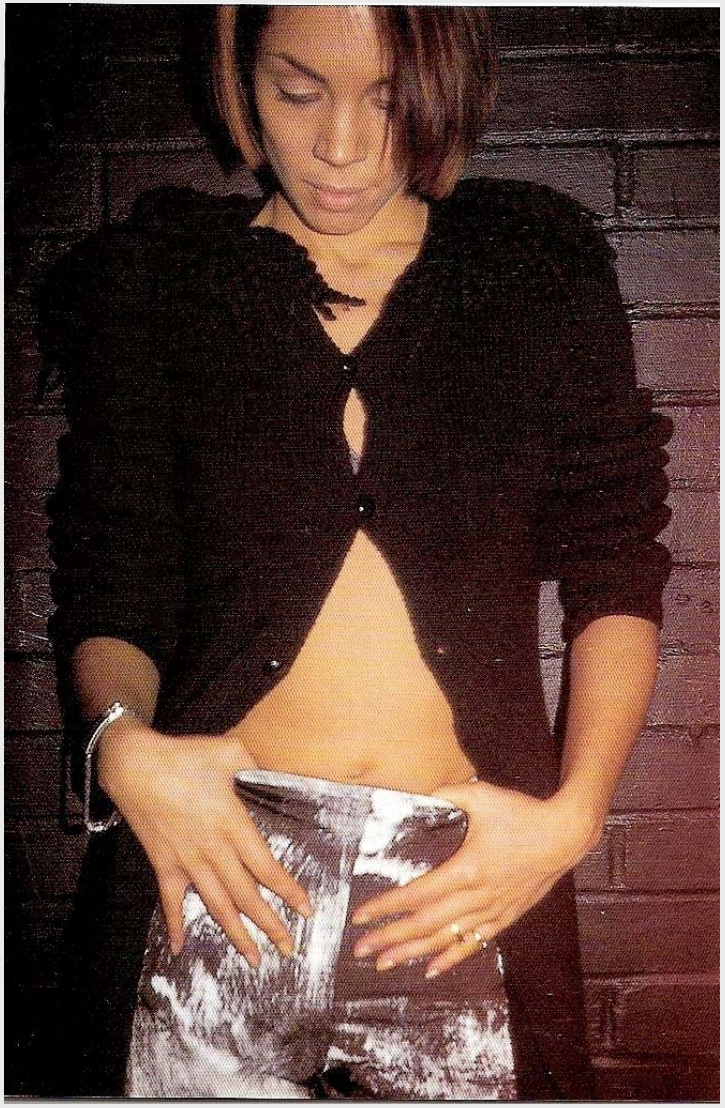
Retro reflective inks

Rebecca Earley / Giovanna Palmero
Reflective hand printed trousers
1996

High quality microfiber from the French company **Sofieta** were hand printed with retro reflective ink by **Technology Industries, Manchester.** Black ink was then added and fixed in a heat press, producing this effect.



Techno Textiles, S.E. Braddock et al., Thames & Hudson



Retro reflective fabrics

Suzanne Whitehead
Polyamide with reflective strips 1996

This is made using a transparent polyamide industrially pleated. It is combined with strips of reflective fabric to create a dynamic surface that constantly changes and reflects light.

Techno Textiles, S.E. Braddock et al., Thames & Hudson

Retro reflective yarns

Kathy Schicker
woven sample with retro reflective yarns
2008

Kathy wove this fabric using retro reflective yarn from **Lurex.** It is a supported yarn, enabling it to be woven on an industrial loom.

Supported yarn is the retro reflective yarn mixed with another, stronger yarn, that stops it from breaking or stretching.
The side effect of using a supported yarn is that it is less reflective.

www.lurex.com

Phosphorescent films

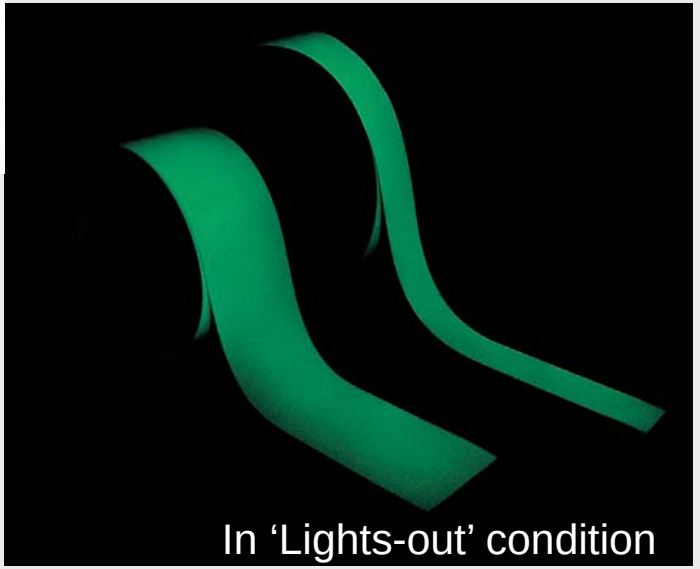
Photoluminescence is a process in which a substance absorbs photons and then re-radiates photons.

With **Phosphorescent** materials, the energy from absorbed photons undergoes transition into a state of higher spin multiplicity, usually a triplet state.

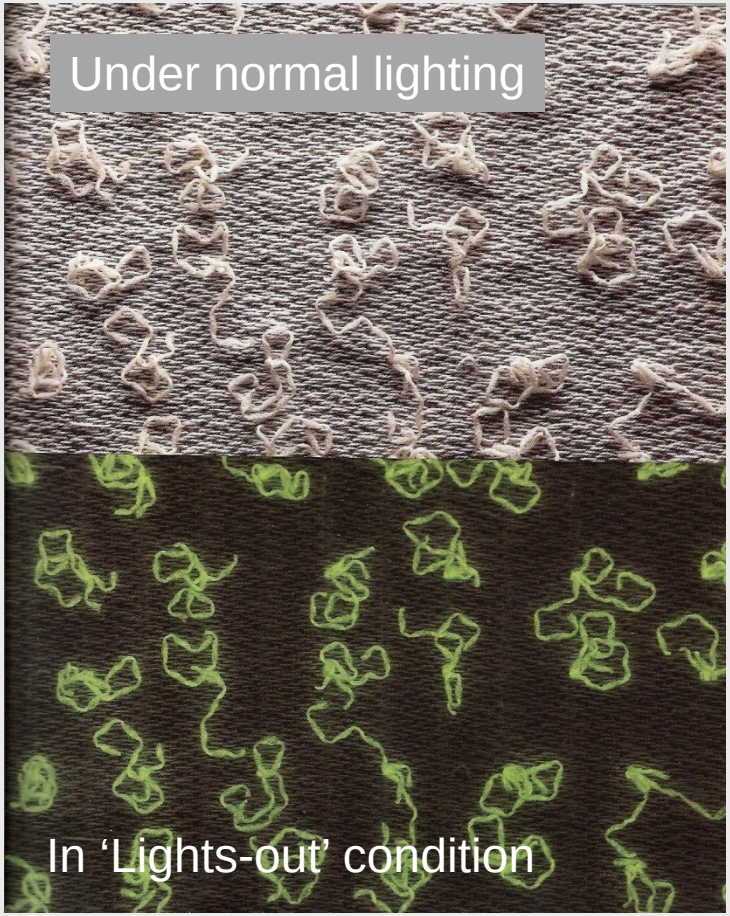
Once the energy is trapped in the triplet state, transition back to the lower singlet energy states is quantum mechanically forbidden, meaning that it happens much more slowly than other transitions. The result is a slow process of radiative transition back to the singlet state, sometimes lasting minutes or hours.

This is the basis for "glow in the dark" substances. Applications in signage and worker security.

Wikipedia



Phosphorescent yarns



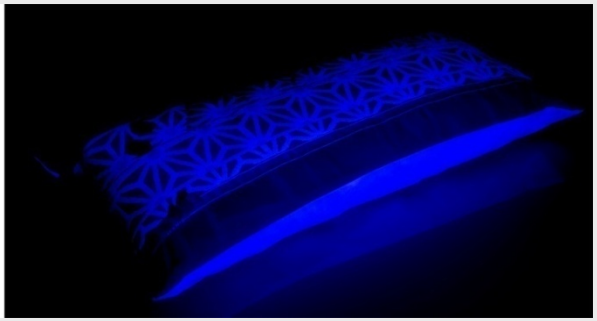
Techno Textiles, S.E. Braddock et al., Thames & Hudson

Under normal lighting

In ‘Lights-out’ condition

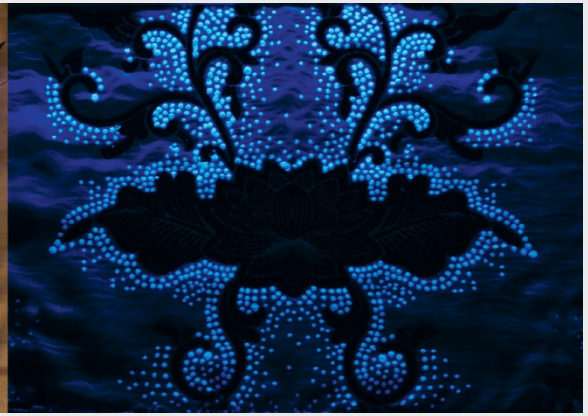
Phosphorescent yarns

Kathy Schicker Woven Light 2008



Photochromic

Phosphorescent



www.solaractiveintl.com

In ‘Lights-out’ condition

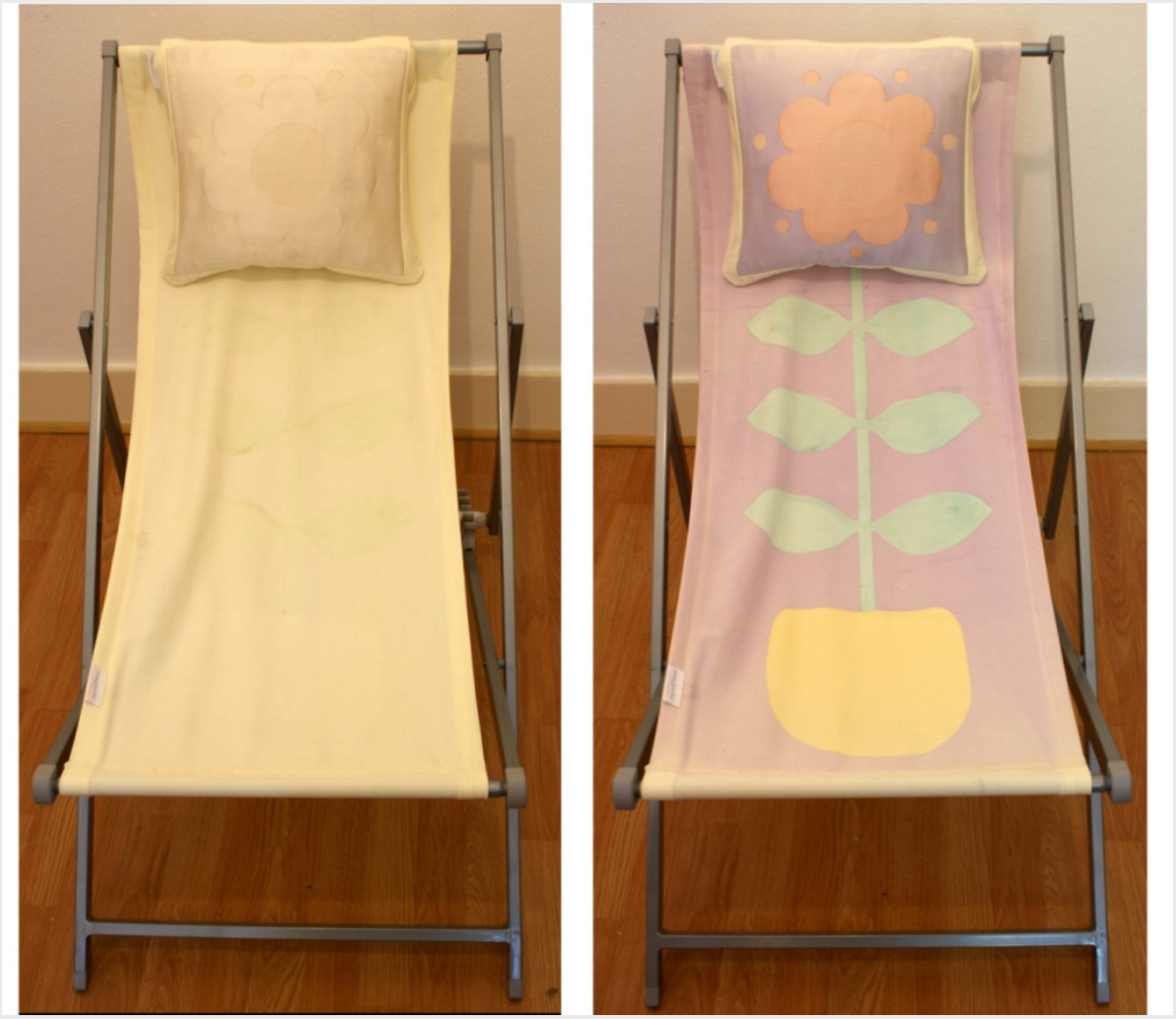
Photochromic inks

These ink change from clear when indoors to colored when taken outdoors. Specifically, they exhibit color in response to exposure to UV light from sunlight, black lights, or similar sources.
UV light changes the chemical structure of the photochromic material and makes it absorb color like a dye. It then reverts to a clear state when the UV source is removed. The color change can occur thousands of times, depending on the application. Photochromics are relatively new, having been introduced in the early 1990s, and their use has steadily increased as manufacturers have gained control over the stabilization process.

www.screenweb.com

One of the most popular uses for photochromic inks is on screen-printed garments. As this design illustrates, the inks are transparent until exposed to a UV light source (sun, black light, etc.), at which time they take on their specific color characteristics. They return to a transparent state when UV exposure is discontinued

Photochromic inks



Kathy Schicker, photochromic deckchair, 2008

Photochromic yarns

Kathy Schicker
Woven Light
2008

Kathy integrated Photochromic fibres into her high end woven Jacquard textiles. These fibres undergo a reversible colour change when exposed to sunlight
As the function is part of the material, it needs no other power or technology except sunlight. Different aspects of the design are revealed depending on the time of day and lighting conditions.

Without sunlight

In sunlight

ÉCOLE POLYTECHNIQUE MONTRÉAL

PolyPhotonique

Photochromic yarns

University of the Arts London

Thermochromic inks

Thermochromic inks change color in response to temperature fluctuations. This change is reversible and will change colors over and over again with the appropriate exposure.

The two types of thermochromic inks are liquid crystals and leucodyes.

Liquid crystals are used in many products, including aquarium thermometers, stress testers, and forehead thermometers. Unfortunately, liquid crystal thermochromic are very difficult to work with and require highly specialized printing and handling techniques.

Leucodye thermochromic are used in a wide range of applications including security printing, novelty stickers, product labels, advertising specialties, and textiles. In its cool state, a leucodye exhibits color, and when warmed, it turns clear or translucent. It takes a 5-10°F (3-6°C) shift to bring about a change in color

Liquid crystals

Leucodye

www.screenweb.com

Thermochromic inks

Aeden Mun

Interior wall paper that indicate changes in weather patterns through patterns in the wallpaper.

Thermochromic inks, laser cutting

www.textilefutures.co.uk

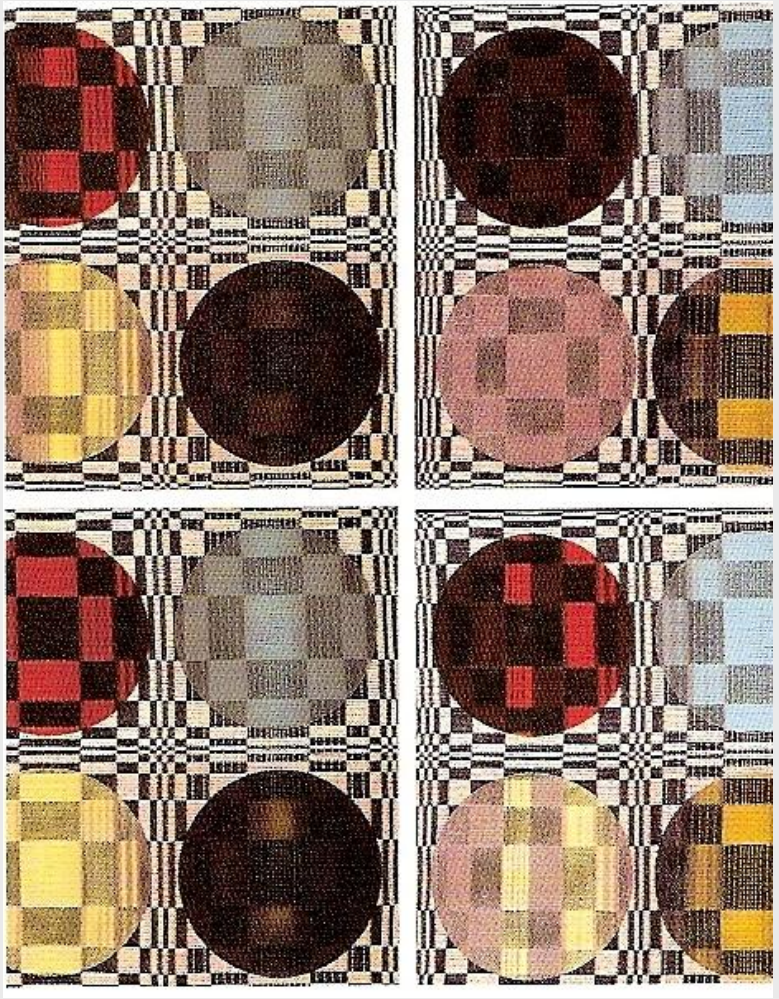
Thermochromic inks

Maggie Orth
International fashion machines
Dynamic double weaves 2004

This project explores how software can interact with a regular print design on a printed and woven textile.

The textile is woven with conductive threads and over printed with thermochromic inks.

Random patterns are generated, heating the conductive threads and changing the colour of the inks.



Fashionable technology, S. Seymore, Springer

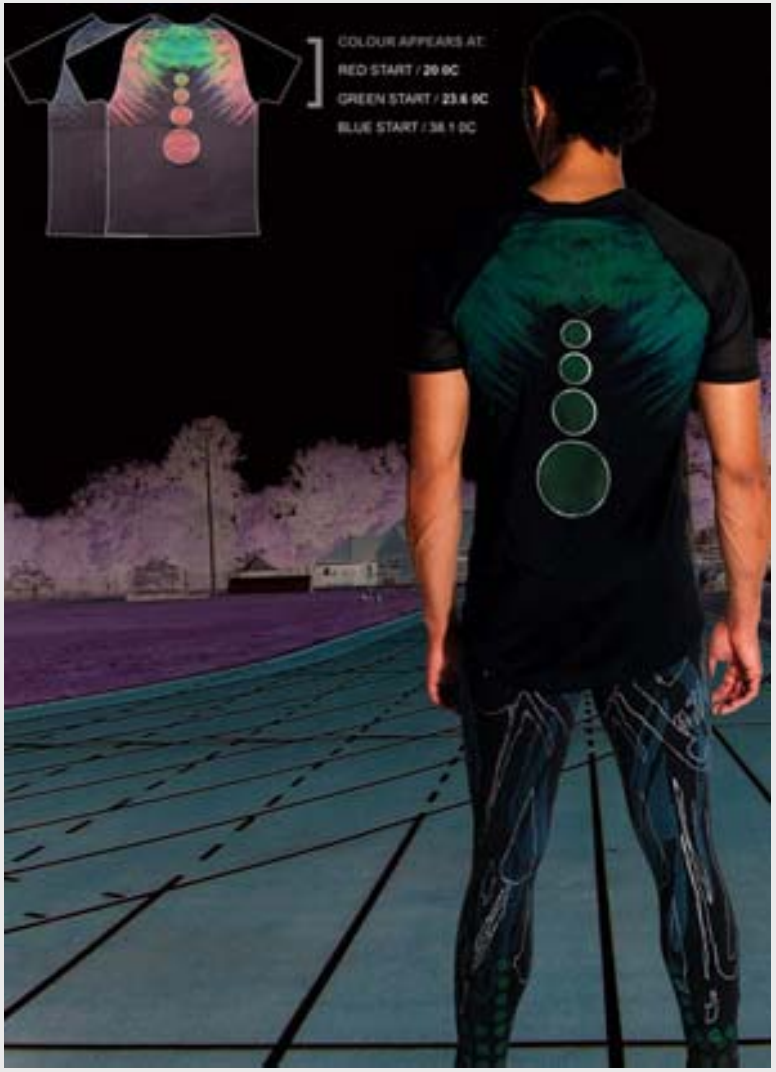
Thermochromic inks

Kerri Wallace

Motion Response sportswear

Kerri creates motion responsive fabrics for sportswear.
She is using correlations between heart rate and body temperature as a trigger for change and form of visual monitoring, creating evolutional interactive textiles.

www.textilefutures.co.uk



Enabling technologies for light emission

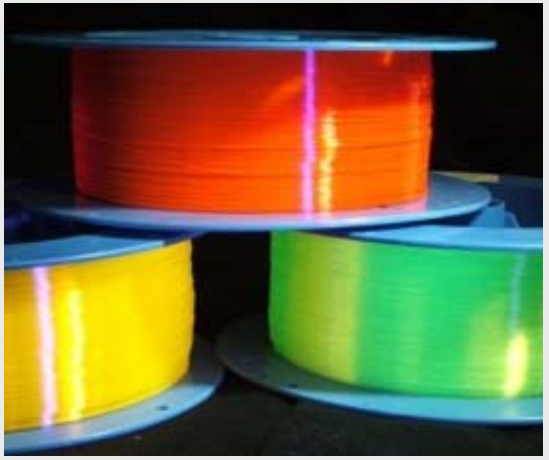
- Fluorescent fibers
- Electroluminescent wires and sheets
- LED’s
- Optical fibers (Total Internal Reflection - standard)
- Photonic Bandgap fibers

Fluorescent fibers

Fluorescence

is a luminescence that is mostly found as an optical phenomenon in cold bodies, in which the molecular absorption of a photon triggers the emission of a photon with a longer (less energetic) wavelength. The energy difference between the absorbed and emitted photons ends up as molecular rotations, vibrations or heat. Sometimes the absorbed photon is in the ultraviolet range, and the emitted light is in the visible range. Applications in lighting, gun and bow sights, hunting sights and in scintillators.

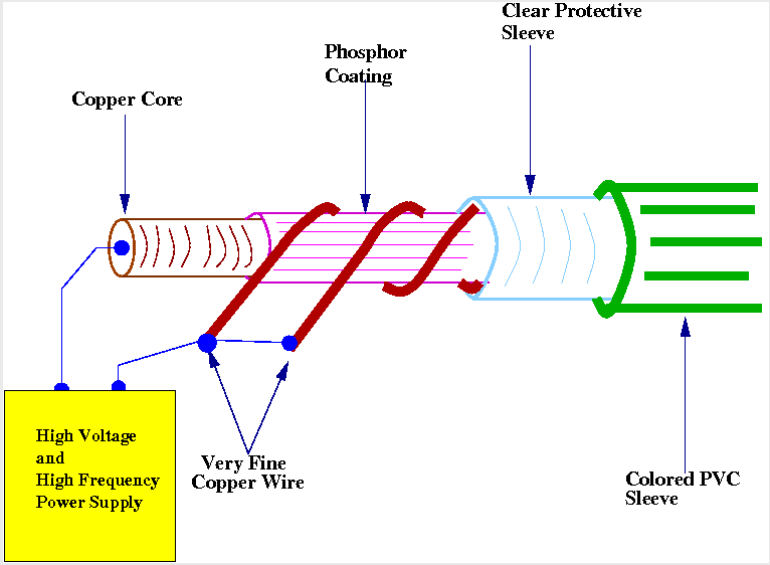
Wikipedia



Electroluminescent wire

Electroluminescence

is an optical phenomenon and electrical phenomenon in which a material emits light in response to an electric current passed through it, or to a strong electric field. Electroluminescence is the result of radioactive recombination of electrons and holes in a material. The excited electrons release their energy as photons - light. Prior to recombination, electrons and holes are separated through excitation by impact of high-energy electrons accelerated by a strong electric field (as with the phosphors in electroluminescent wires).



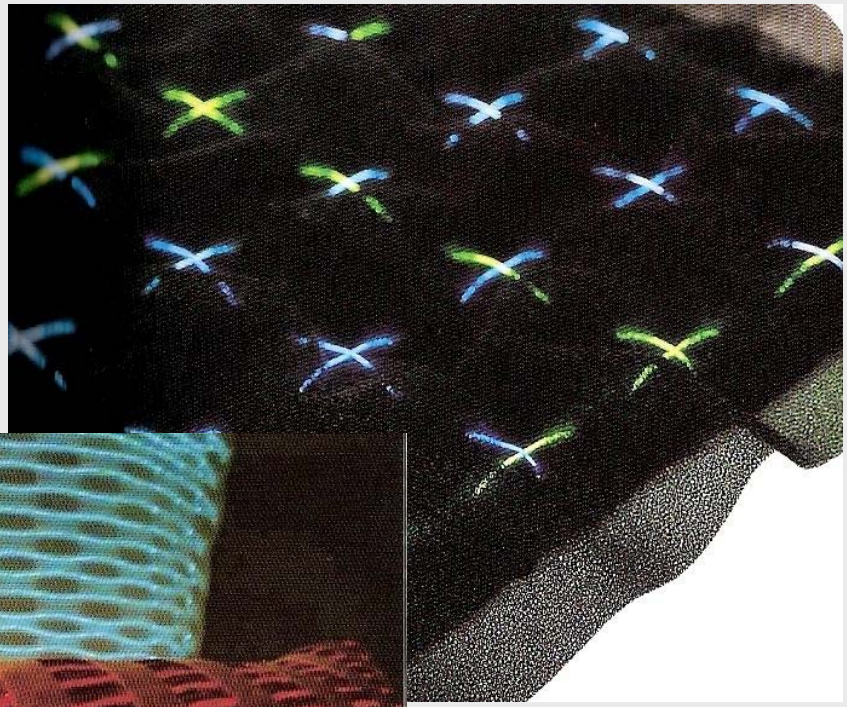
Electroluminescent wire

is a thin copper wire coated in a phosphor which glows when an AC Current is applied to it. It can be used in a wide variety of applications- vehicle and/or structure decoration, safety and emergency lighting, toys and clothing

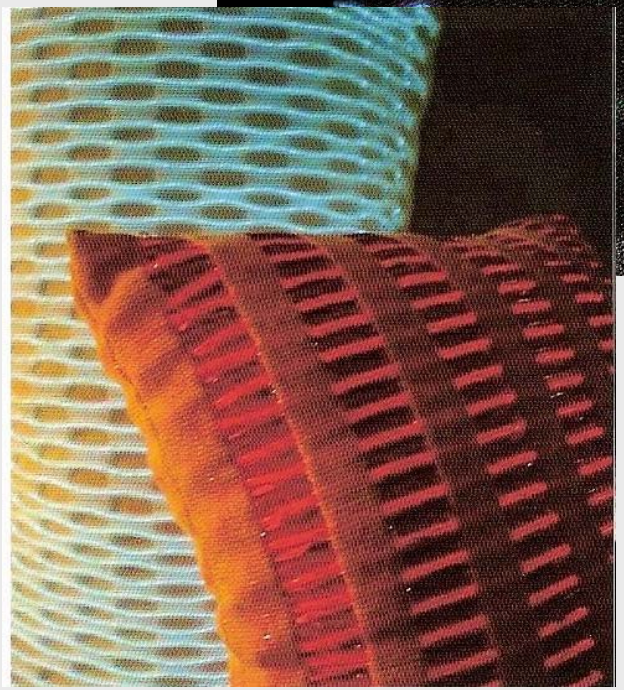
Wikipedia

Electroluminescent wire

Ryoko Yamanaka
Splashed line 2003
This textile is created using bonded polyurethane stitched with EL wire
This has a dual function as an art piece and for design use.



The interactive institute,
Play Studio
The interactive pillow are based on the idea that pillows should be able to interact regardless of distance. When one of the pillows is hugged or leaned against, the pattern of the other pillow changes its design. The pillows were made with a mixture of wool, EL wire and effect yarn on an industrial loom.



Fashionable technology, S. Seymore, Springer

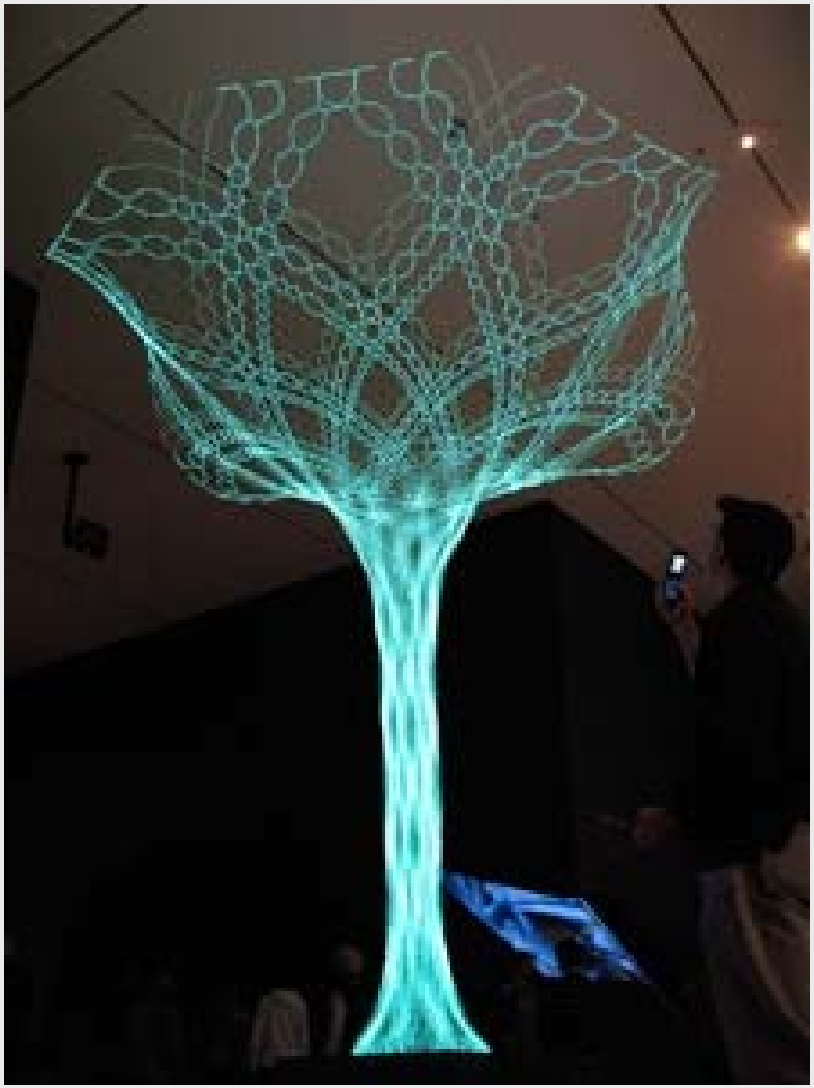
Electroluminescent wire

Loop.ph
Rachel Wingfield and Mathias Gmachl
Sonumbra 2006

This installation using interlaced EL wire is designed to respond to the interplay and activity of the people orbiting the umbrella.
The atmosphere of musical rhythms, harmonies and luminous patterns are composed by the visitors' movement - either active or passive.

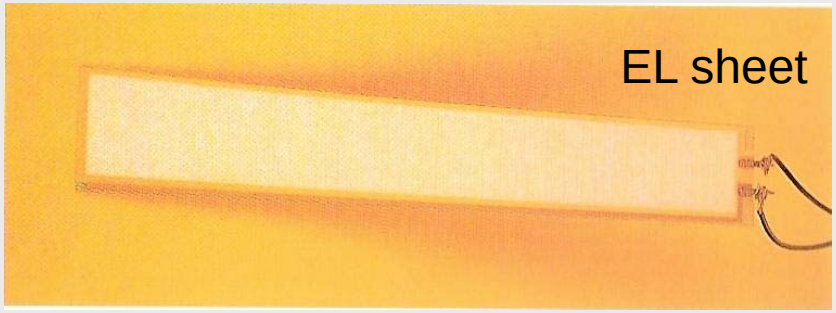
Wandering unaware or actively gravitating towards Sonumbra each person plays a part and becomes a note in a unique composition of light, sound and space.

www.loop.ph

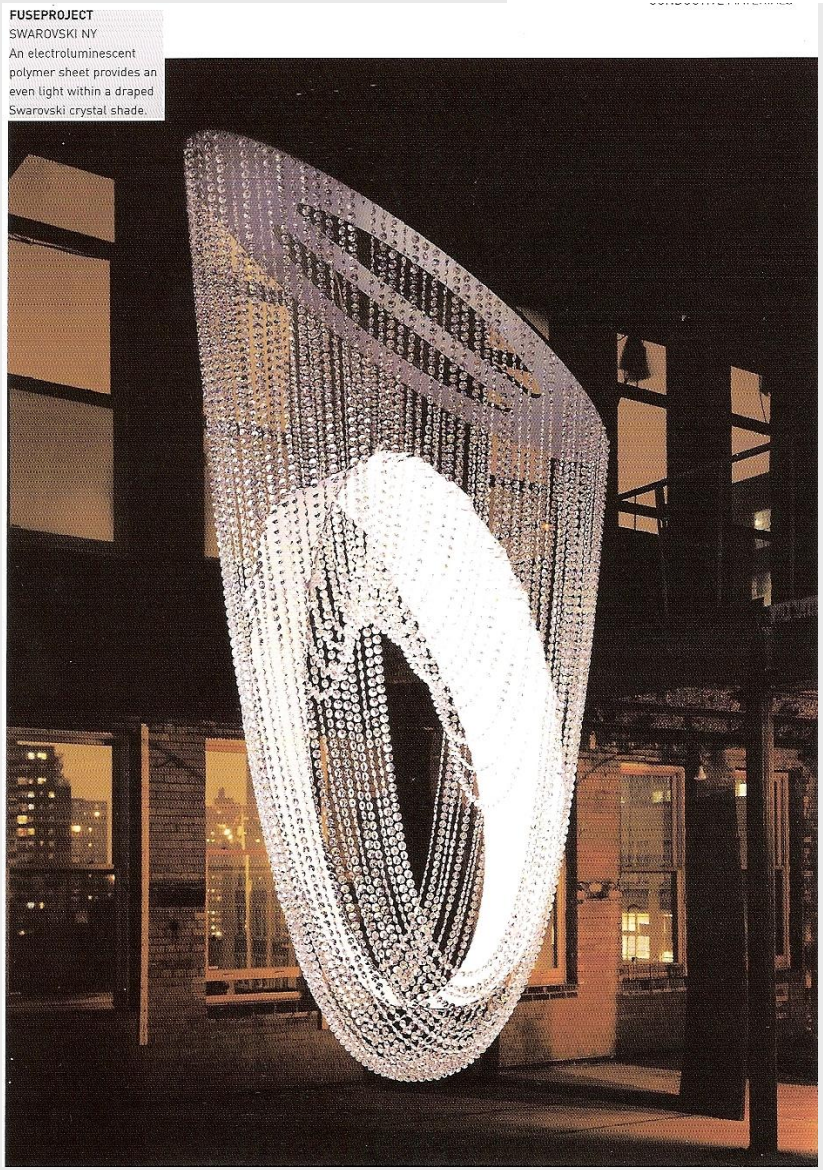


Electroluminescent sheets

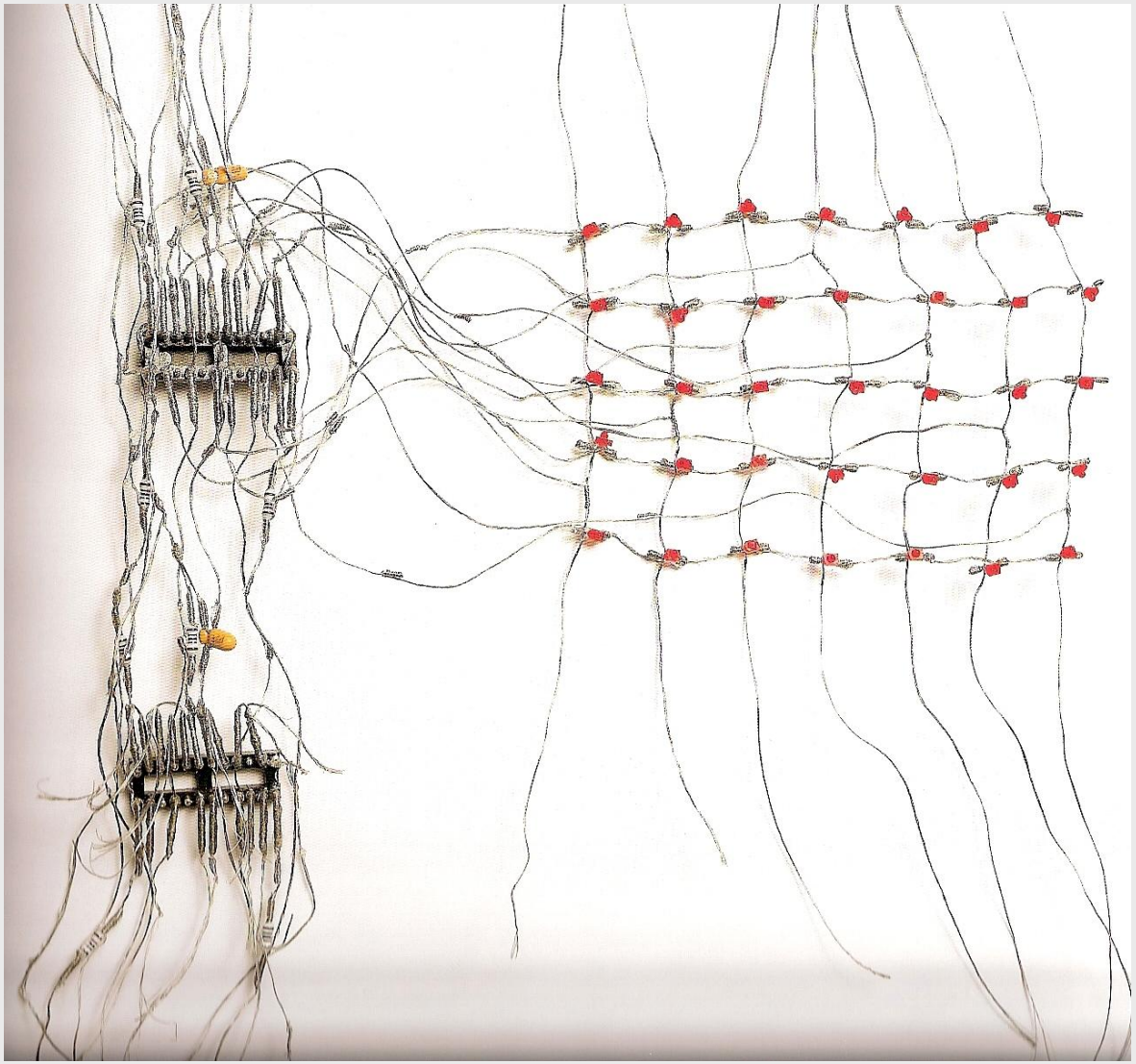
Material ConneXion, G.M. Beyleruan et al., Thames&Hudson



The world's first electroluminescent billboard campaign, Canada, Winter 2005



Light Emitting Diodes (LEDs)



Techno Textiles, S.E. Braddock et al., Thames & Hudson

Fine features, dynamic appearances with LEDs

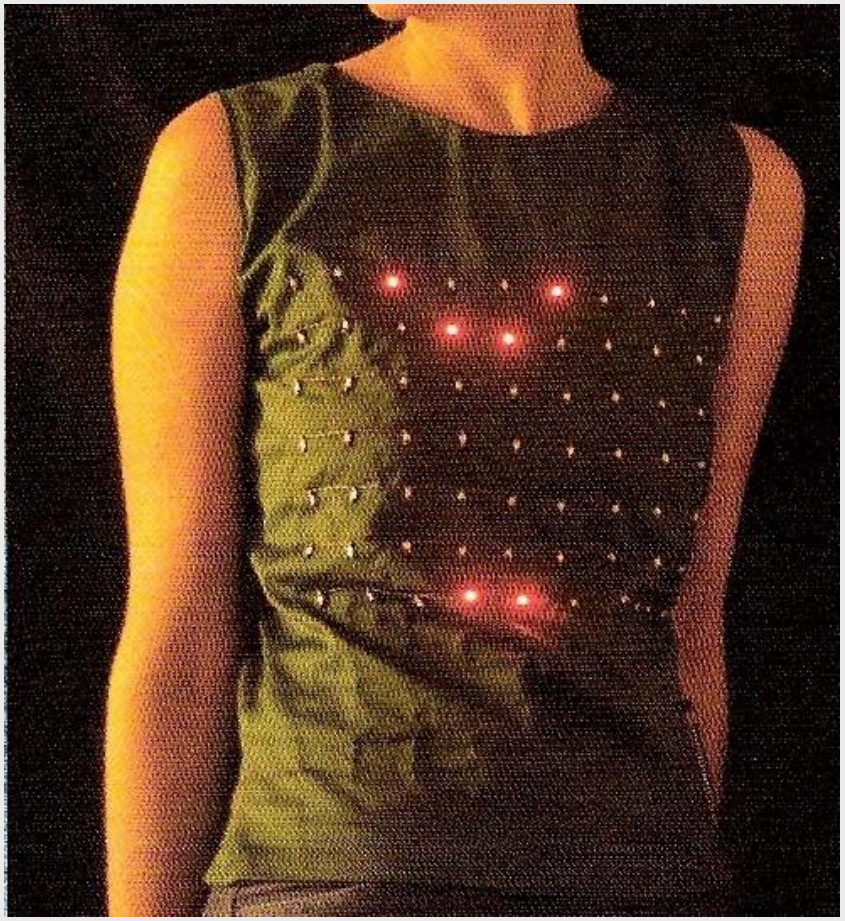
Craft Technology group, University of Colorado

The shirt is a programmable wearable garment and acts as a low- resolution display.

It is programmed with cellular automation and text animations.

An embedded IR receiver allows the wearer to set its pattern with a PDA. The shirt was released as a DIY project on MAKE Magazine

Fashionable technology, S. Seymore, Springer



Fine features with LEDs

Barbara Layne
Hexagram
Concordia University
Montreal

Jacket Antics

Natural materials are woven in alongside microcomputers and sensors to create surfaces that are receptive and responsive to external stimuli. Controllable arrays of Light Emitting Diodes present changing patterns and texts through the structure of cloth. Wireless transmission systems support real time communication.

Fine features with LEDs

Stijn Ossevort

Flare 2007

The flare dress is designed to perceive the wind. Using two fabric layers, the outside is covered in 15 Dandelions. These flowers are made of 32 LEDs that light up sequence that simulates the dandelions seedlings being blown away in the wind.

Only the flowers that face the wind become active, and as the wind gets more responsive the dress becomes

Dynamic appearances with LED-based textiles

Philips Electronics
Lumalive

LED-based light emitting textiles
Philips Lumalive is a new medium to convey emotions and messages. They use colorful dynamic animations on textile products like garments, to make an unexpected striking appearance.

By integrating multicolor LEDs (light-emitting diodes) into textile objects Philips Lumalive transforms them into communication platforms, while their textile look & feel retains.

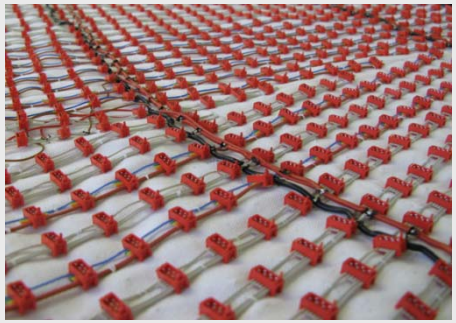
Its aims to be a distinctive way to experience, communicate and personalize.

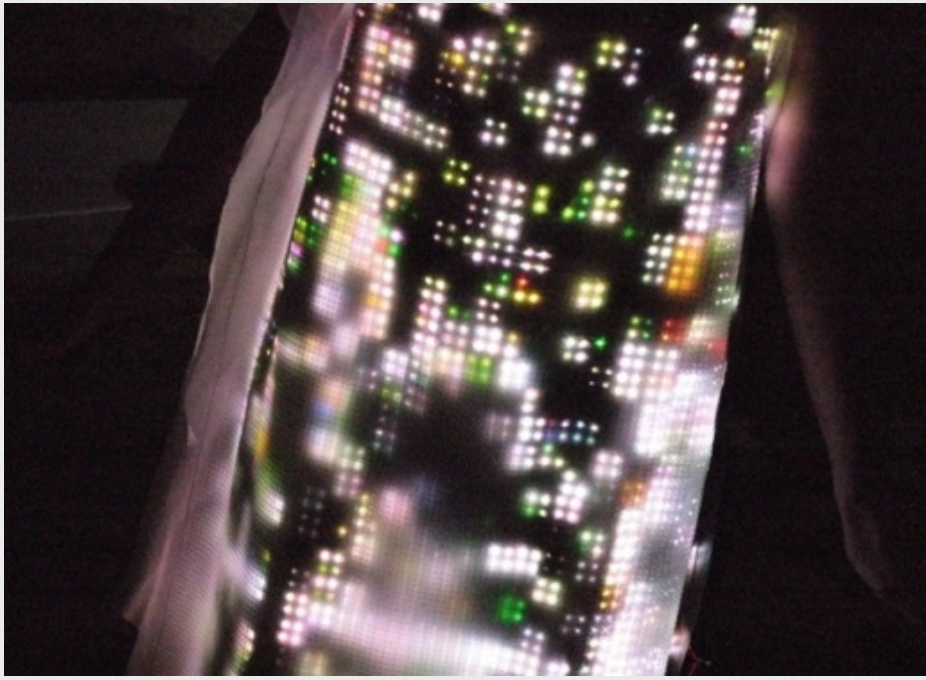
Dynamic appearances with LED-based textiles

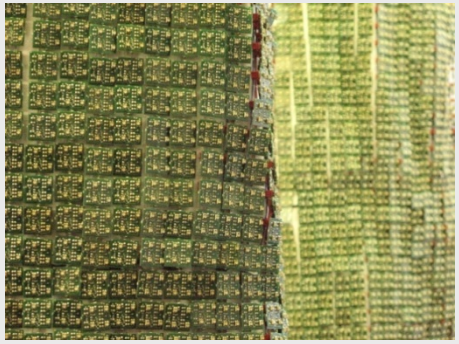
Hussein Chalayan
with Morizt
Waldemeyer
Airborne
2008

The Video dresses were created by 15000 LEDs embedded beneath the fabric. One dress displays hazy silhouettes of sharks in the sea whilst the other shows a time-lapse sequence of a rose blooming then retracting. The effect is mesmerizing in its ambiguity: the loose white fabric covering the LEDS blurs and distorts the images so that they seem to pulsate in and out of existence.

Dynamic appearances with LED-based textiles







The design brief was to create two video dresses that would show video sequences across the entire surface of the dress. There were just 4 weeks from the go ahead to the show, demanding a very pragmatic approach: no exotic components or materials, just off the shelf components and standard manufacturing techniques.

Dynamic appearances with LED-based textiles

Philips Electronics
Bubelle

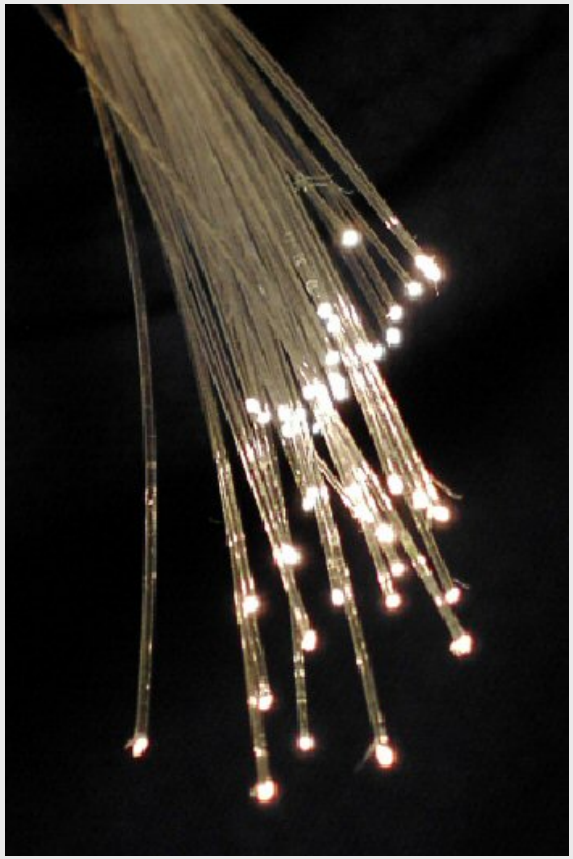
The Emotion Sensing Dress of the future created as part of the SKIN project exploring concepts around how our future garments could be more ‘Sensitive’ rather than ‘intelligent’.

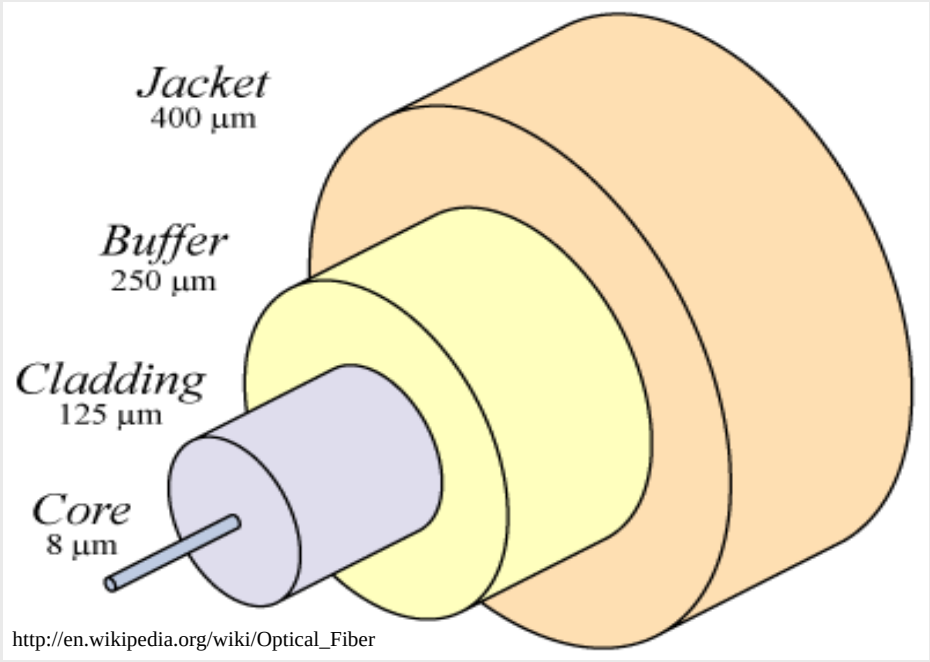
The dress is made up of two layers, the inner layer contains biometric sensors that pick up a person’s emotions and projects them in colors onto the second layer, the outer textile.

The dress changes the look instantaneously according to our emotional state and our personality.

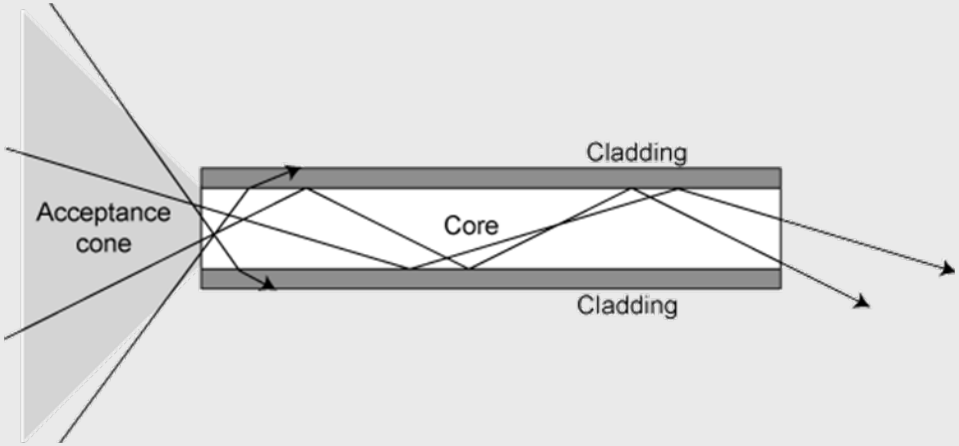
Total Internal Reflection (conventional) optical fibers re-cap

Very efficient guiding in the fiber core, almost no light escapes sideways



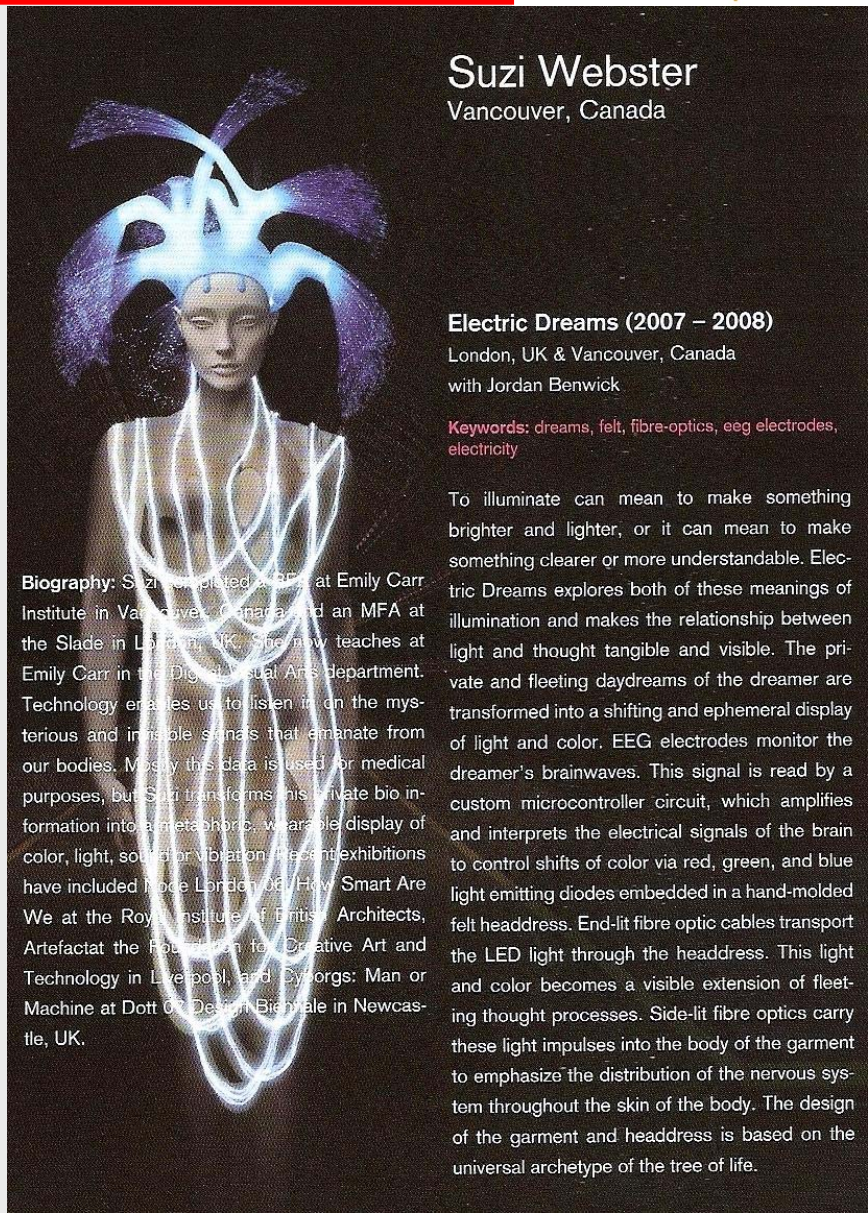


http://en.wikipedia.org/wiki/Optical_Fiber



Simplest application: fiber optic point illuminators (no modification to the fibers)

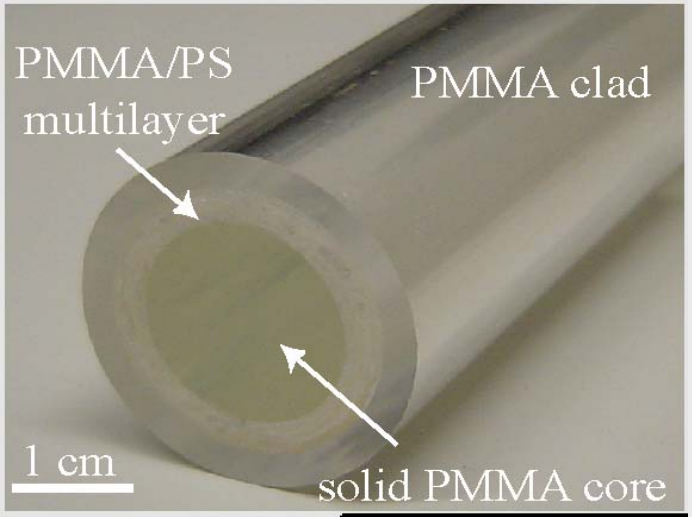
Fashionable technology, S. Seymore, Springer

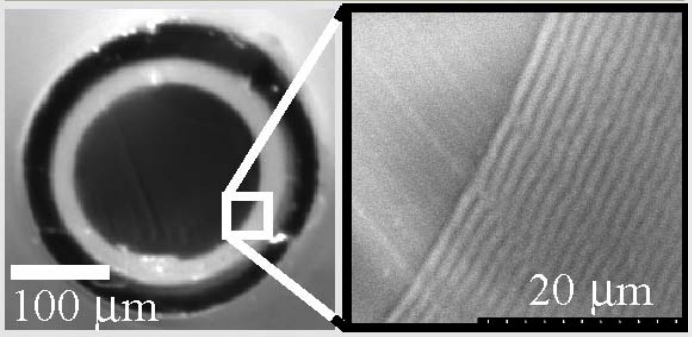


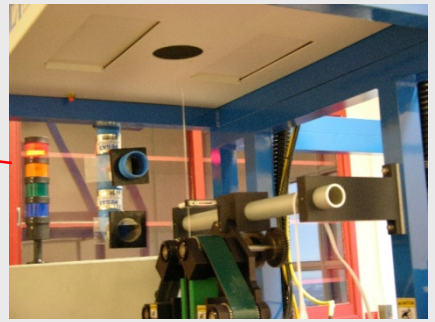
Fiber drawing re-cap

Fiber preform fabrication

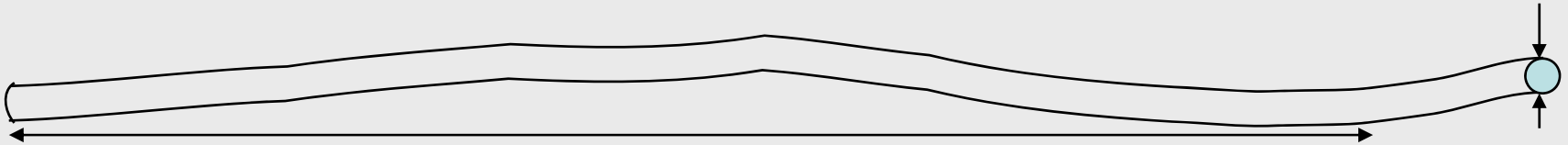
Fiber drawing







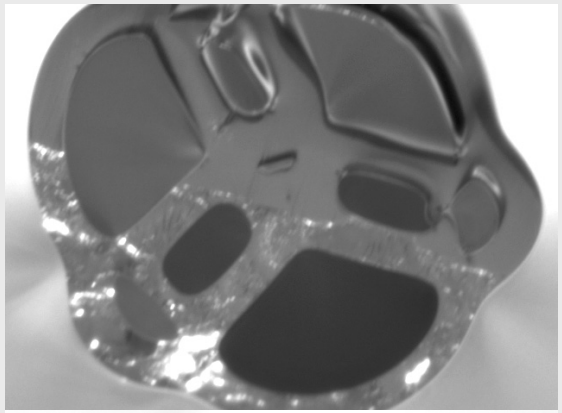
Micro/nanostructured fibers

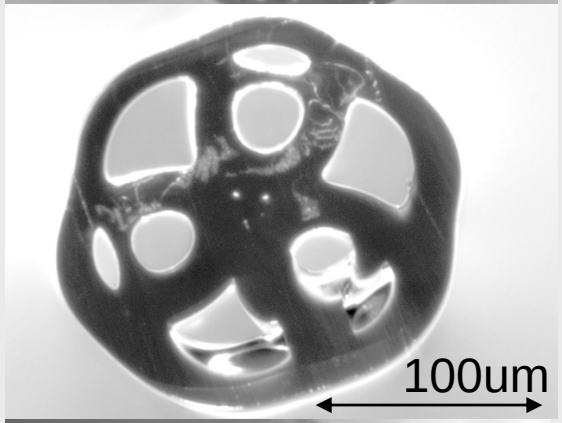


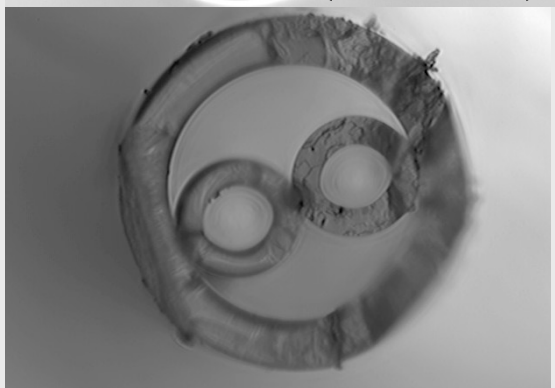
Advantages of fiber drawing, non-optical applications of microstructured fibers

Novel functionalities

1. Fibers of very complex transverse geometries can be fabricated.
2. Several distinct materials (plastics, glasses, metals, semiconductors) can be integrated into the fiber crossection to integrate complex functionalities.
3. Starting with macroscopic objects, structures with sub-micron and even nano-sized features can be fabricated.
4. Cost effective (?).





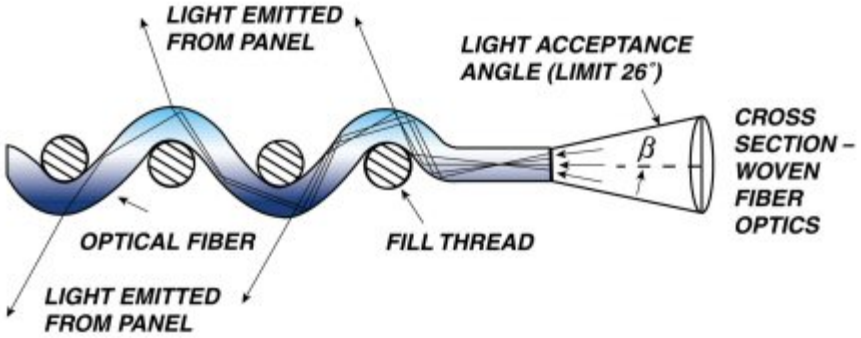


Non-optical applications

1. Empty holes: heat isolating textile
2. Holes filled with phase changing liquids - heat accumulating/releasing textile
3. Holes filled with anti-biotics + semi-permeable cladding – anti-bacterial textile
4. Fiber made of piesoelectric material + integrated metal electrodes – mechanically active textiles

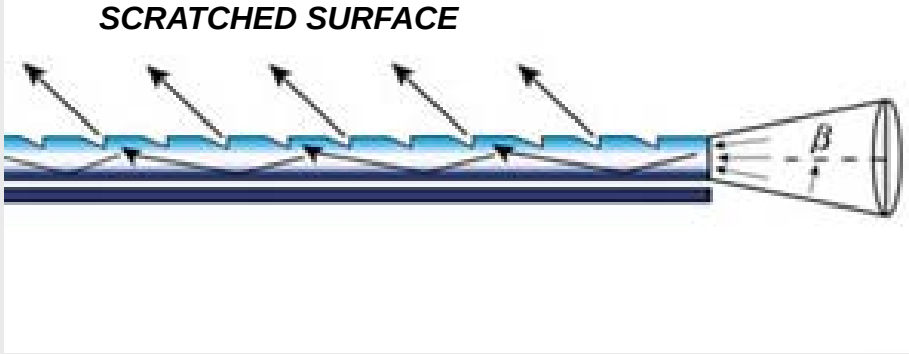
Distributed illumination applications with TIR optical fibers

Technological Problems



Emission control with geometry is complicated, especially when the weft is used as a light-guide.

To ensure uniformity of light emission for the textiles based on bent fibers, textile geometry has to remain constant during wear.



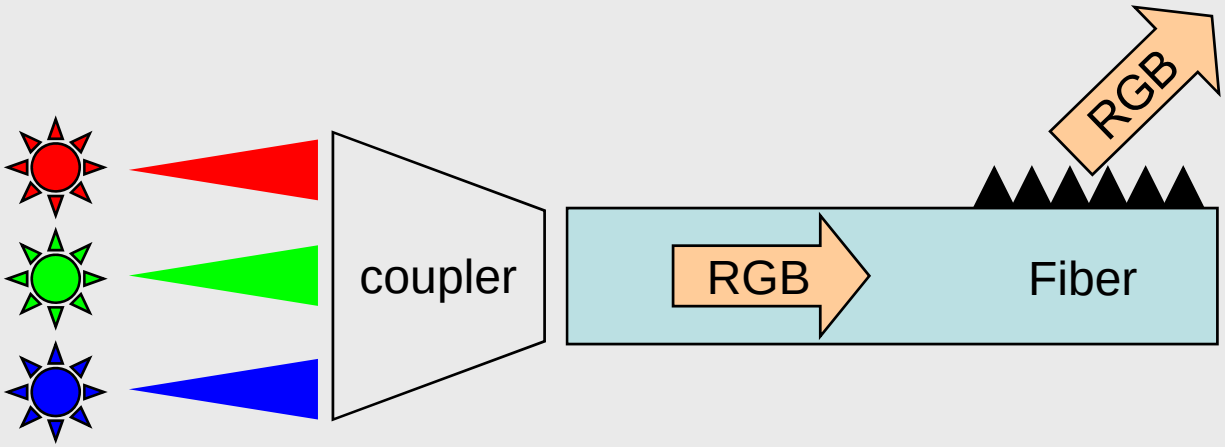
The basic alternative is to scratch the fiber surface to increase the light leakage.

Any notch or scratch may be too coarse; fiber can loose the whole light power at a single or a few points.

Implementing colors in TIR optical fiber illuminators

Technological Problems

Necessity of having 3 different LED color types (RGB), hence high energy consumption, coupling complexity and space constraints, stability of an emitted color over time



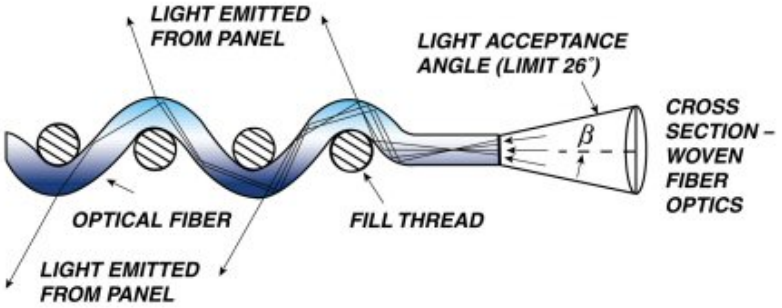
Textiles based on conventional TIR optical fibers

- Woven fiber optic panels for backlighting
- Woven fiber optic textiles for general illumination in décor and fashion
- Woven fiber optic textiles for flexible displays

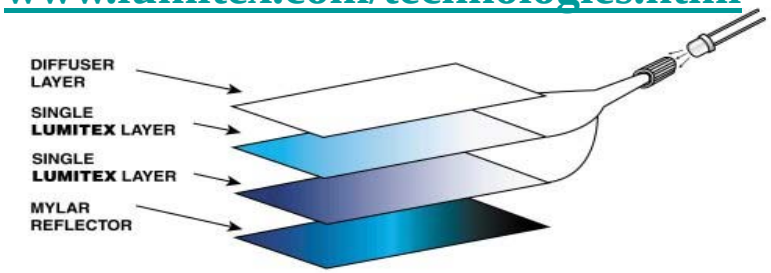
Woven fiber optic panels for backlighting

Lumitex Inc.

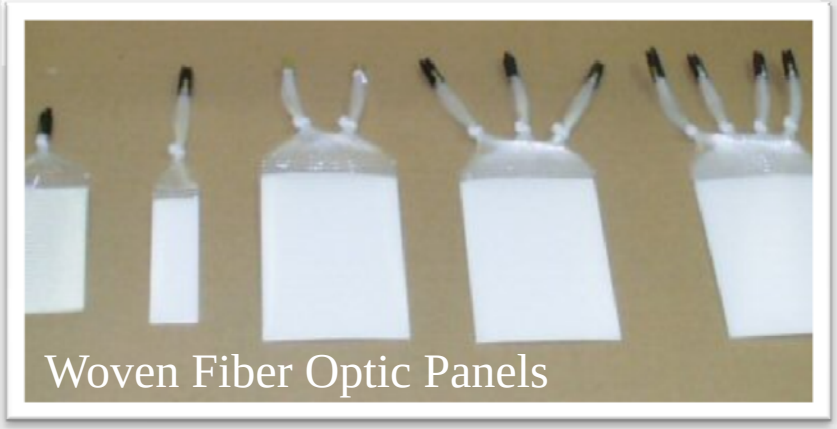
These woven fibre optic panels are woven on a computer controlled loom, creating variable microbends in the optical fiber as it is woven into a cloth. This ensures that the light is emitted uniformly along the length of backlit panel.
This cloth is then laminated into layers to form a panel.
The optical fibers coming off of one end of the light emitting portion are then bundled together in a round ferrule and a light source is attached.



www.lumitex.com/technologies.html

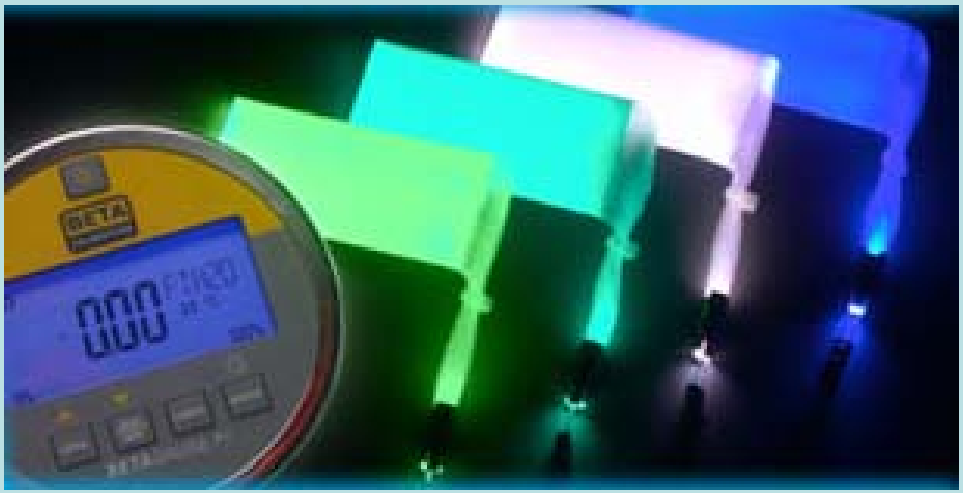



Woven Cloth before being processed into panels


Woven Fiber Optic Panels

Woven fiber optic panels by Lumitex Inc.

LCD Backlighting



Membrane switch backlighting

Surgical lighting (any shapes)

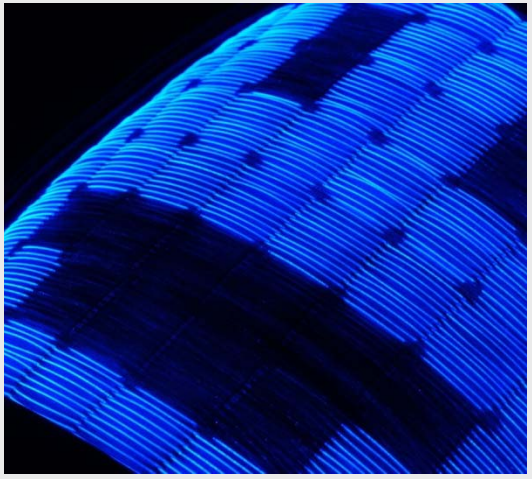
www.lumitex.com/technologies.html

Flexible screens made of woven optical fibres by France Telecom

France Telecom

France Telecom R&D has designed a prototype for a flexible screen made of woven optical fibres capable of downloading and displaying static or animated graphics, such as logos, texts, patterns and scanned images, directly on clothes.

A special abrasion process for the fibers at the surface of the fabric associated to a specific fabric weave developed by the France Telecom laboratories made it possible to create the first bitmap screen matrix on a flexible textile base.



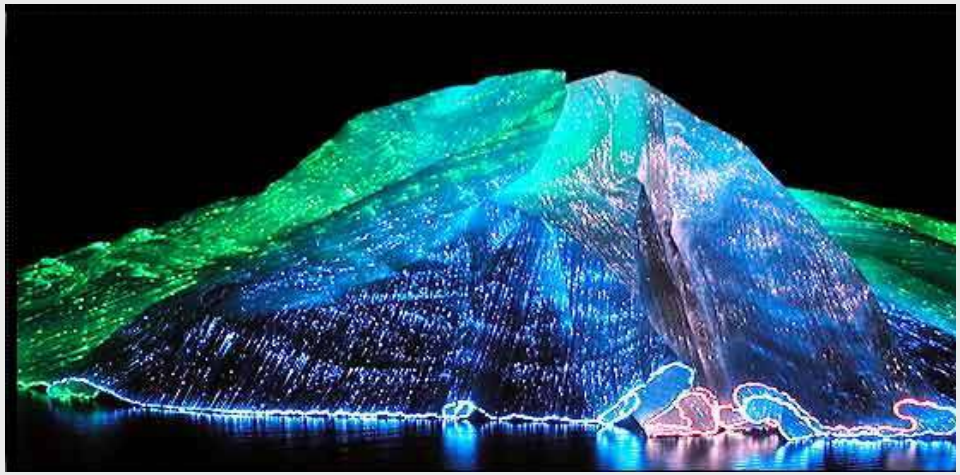
http://www.infotechfrance.com/cgi-local/affichage_signet_secteur.pl?UNI_ID=8&RUB_ID=54&SS_ID=4149&SEC_ID=442

Fiber optic textiles for fashion

Luminex

Luminex has created fabrics that incorporate woven optical fibers for decorative effect.
The optic fibers are woven into a synthetic fiber, the ends of which are bundled together to a point from which LED light is transmitted through filaments.

These emit light along the length as well as the filaments ends.



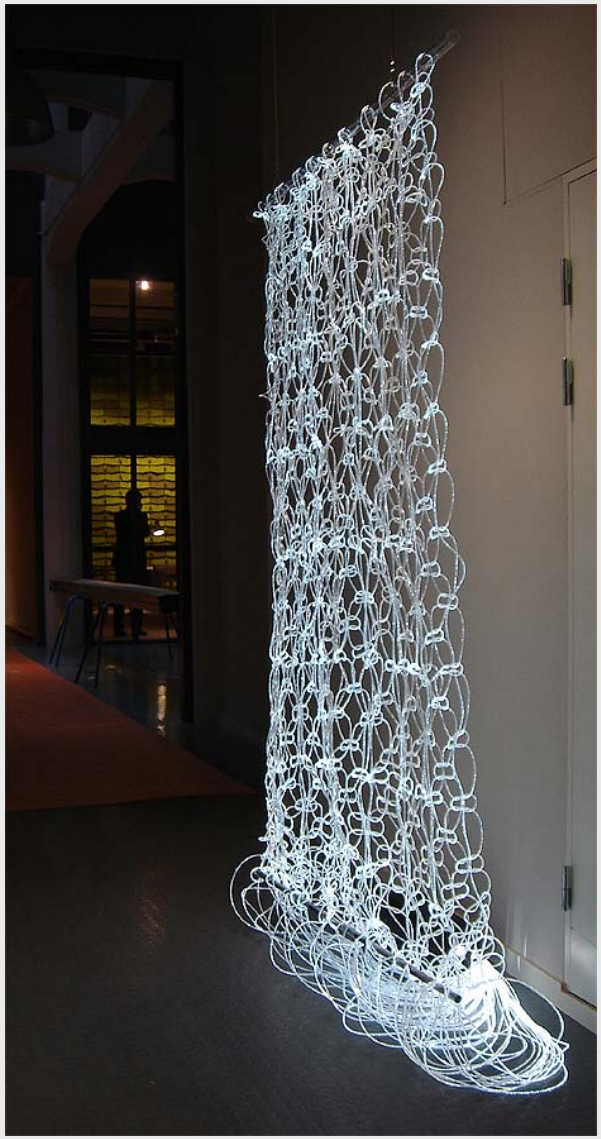
Fiber optic sculptures for décor

Torbjorn Lundell
Glofab

Glofab fibre optic products are created using a series of crochet knots. This style of interlacing works, as the knots of Glofab are all so large, avoiding micro bending the optic fibres.

They also give the textile a beautiful gossamer look which perfectly suits its ethereal glowing quality.

The textile can be hung, framed or laminated in glass. The light source can be anything from a lamp to the sun, and the intensity of the light can be controlled by the generator, allowing for a wide variety of different applications.



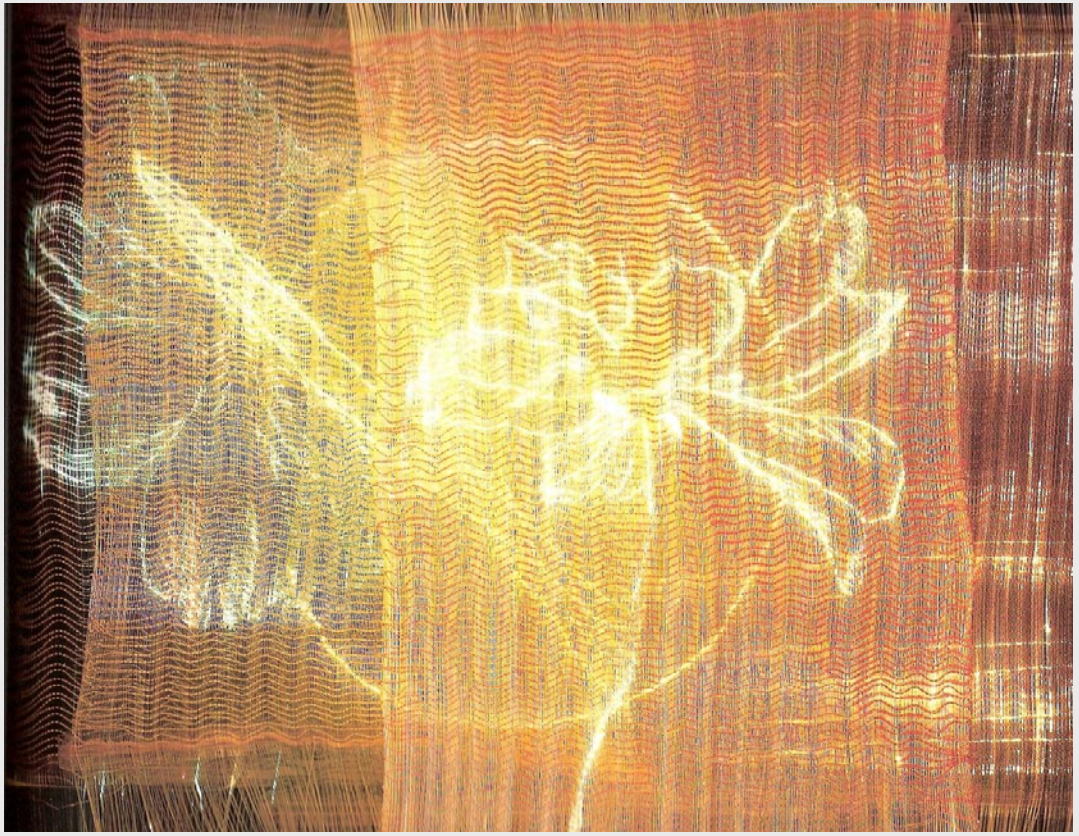
Fiber optic textiles for décor

Kazu Toki

Wind, moon and flowers

This textile piece as been created by five layers of fabric woven on a handloom.

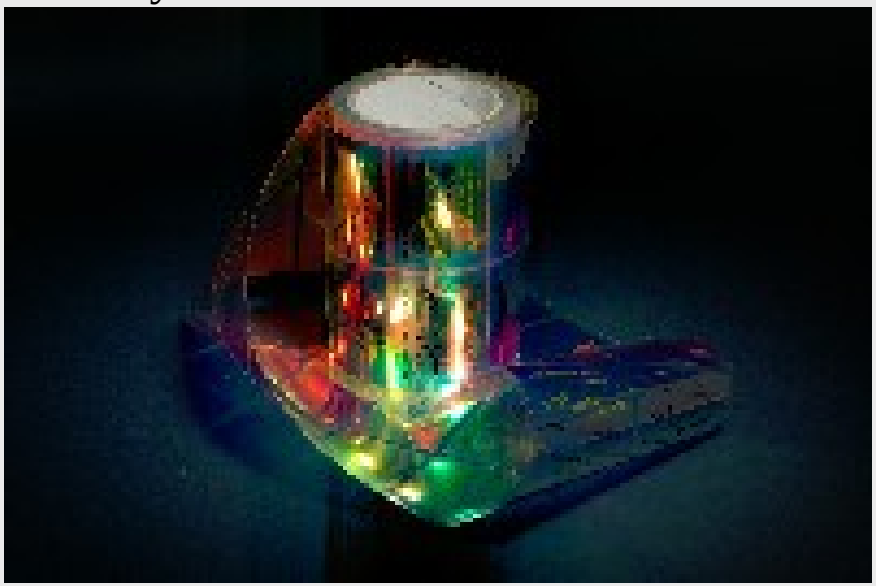
They used 5 different coloured threads traditionally used in Japan, alongside embedded fiber optics, to produce ambiguous, swimming shapes



Techno Textiles, S.E. Braddock et al., Thames & Hudson

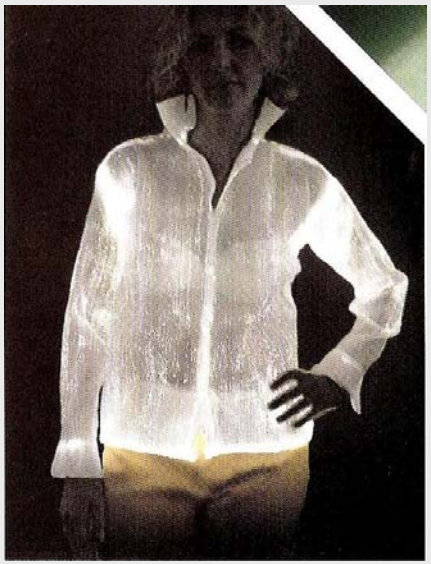
Photonic Crystal Fiber textiles – merging multilayer interference films with fiber optic textiles, and much more …

Multilayer interference film



+

Fiber optic textile



- No need for mechanical deformations for light extraction from the fibers
- Use of a single white light source for color applications
- Color on demand fibers without colorants
- On demand fiber luminosity by geometry design
- Color changing passive fibers

Nature Photonics - Colour-tunable textiles, News and Views, Nov. 2008

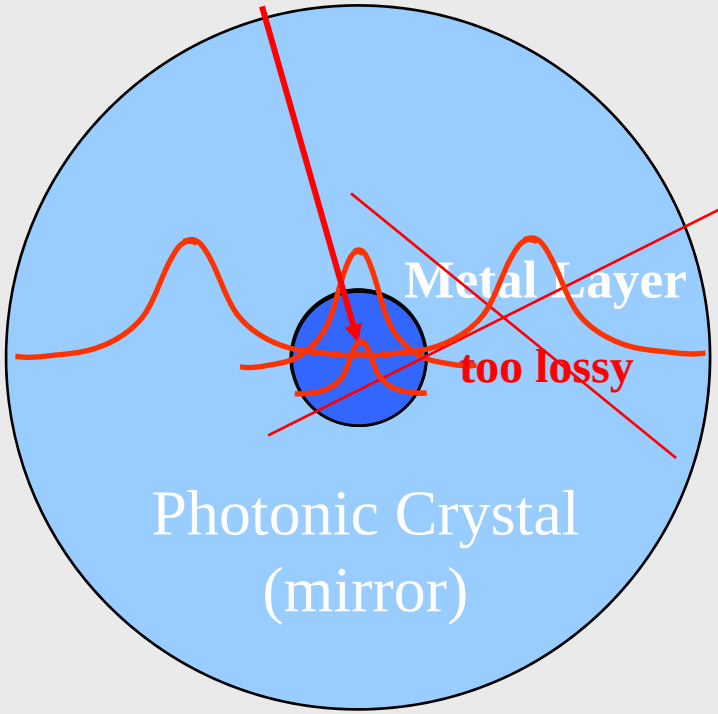
Hollow-Core Photonic Bandgap Fibers

0.2 dB/km @ 1.55μm

1000x better

no transmission above 3μm

loss/nonlinear limits

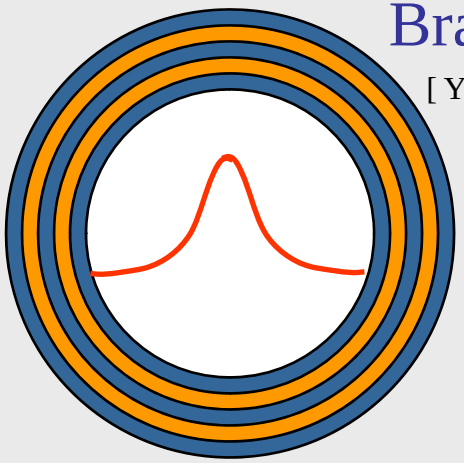


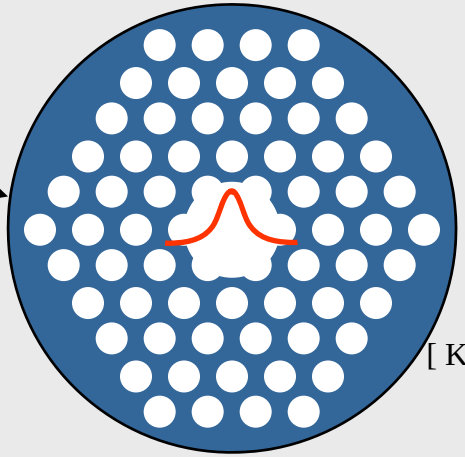
1d crystal

2d crystal

Bragg fiber

[Yeh *et al.*, 1978]





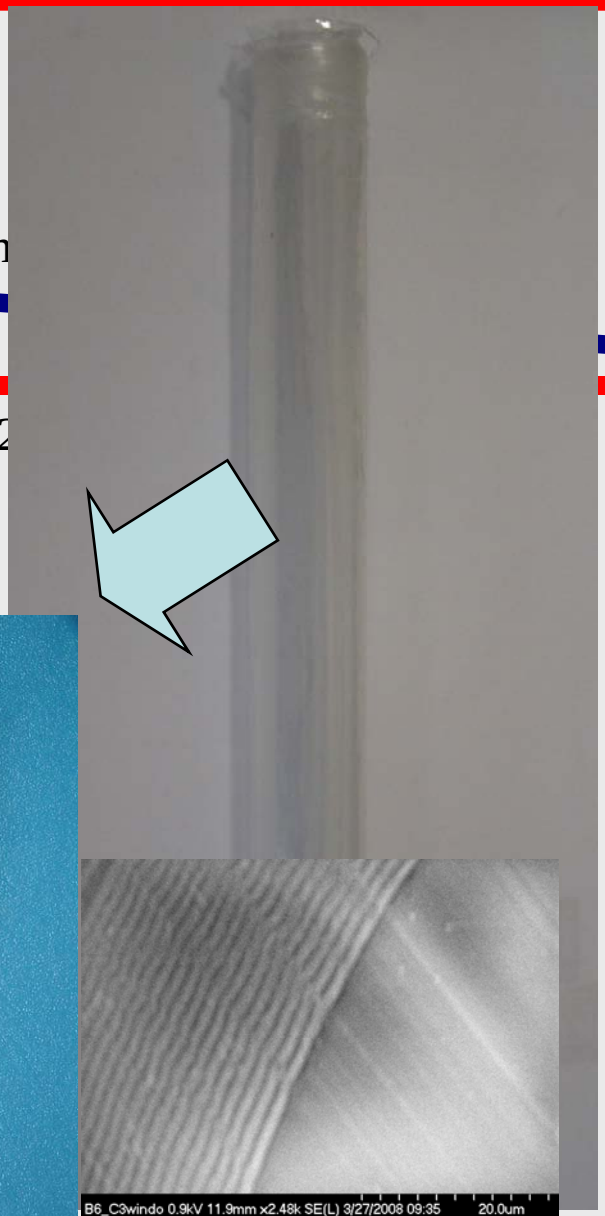
PCF

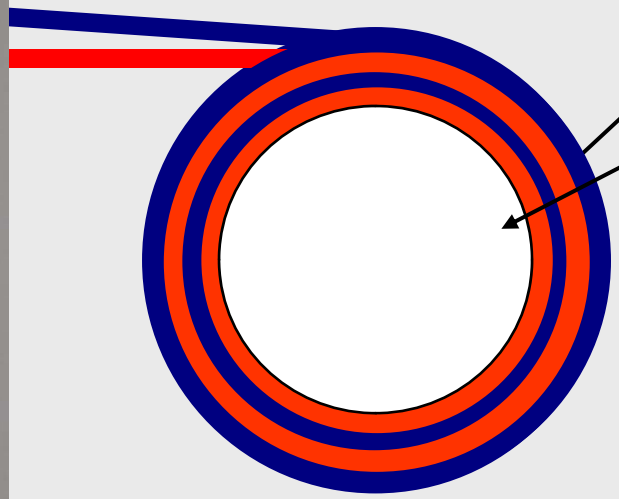
[Knight *et al.*, 1998]

All-Polymer Bragg fiber preforms via Co-Rolling of polymer films

Polymer film

Polymer film 2

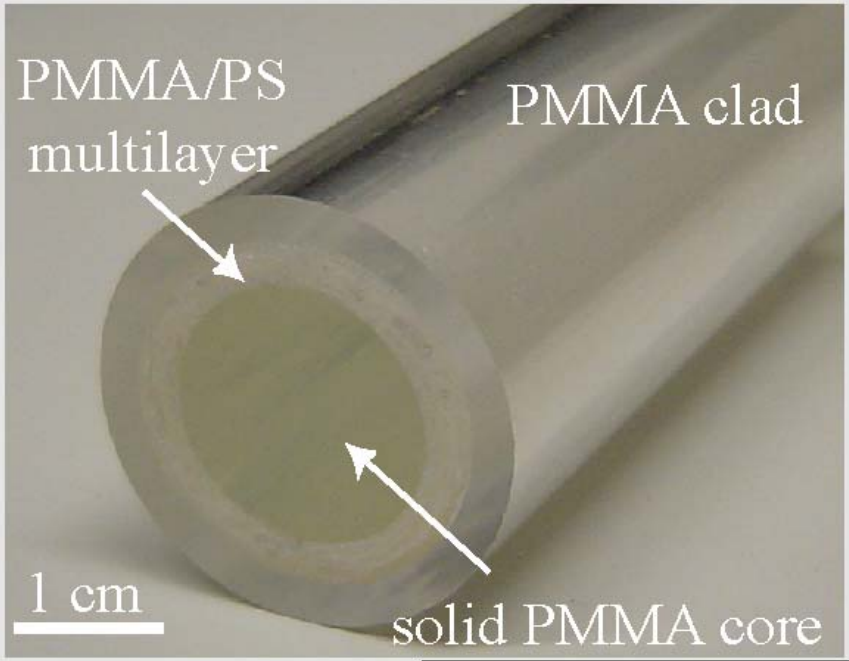


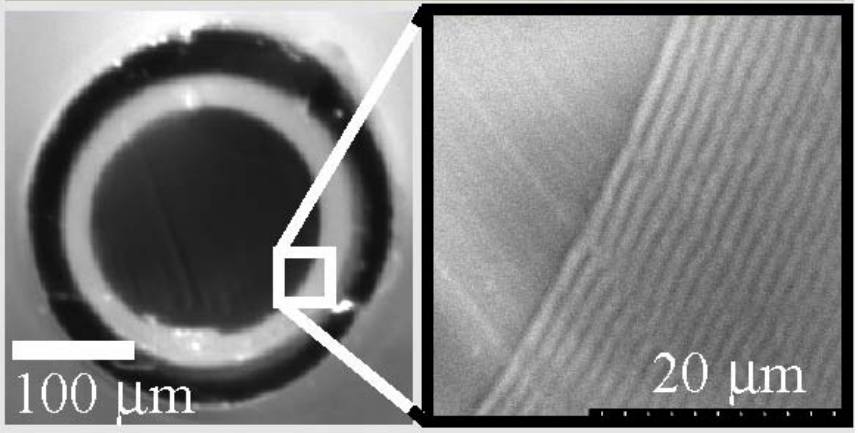


Polymer or glass mandrel (cylinder) can be removed after rolling

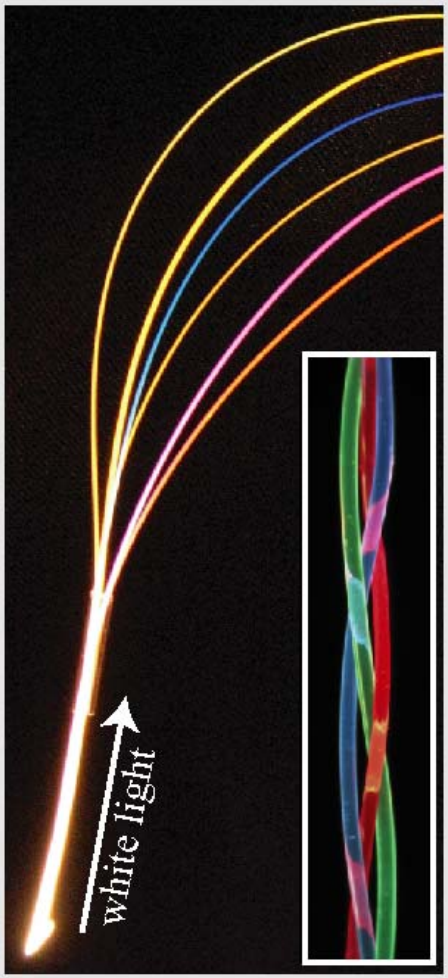
E. Pone, M. Skorobogatiy et al., "Drawing of the hollow all-polymer Bragg fibers," Optics Express **14**, 5838 (2006)

‘ColorFull’ plastic fibers for advanced textiles and short-range communications





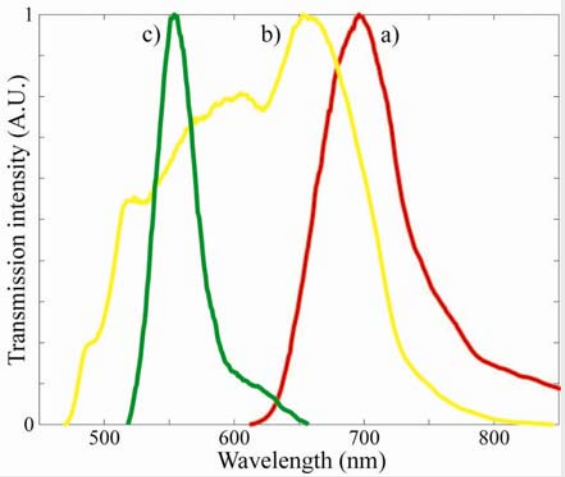
Reflection of ambient light

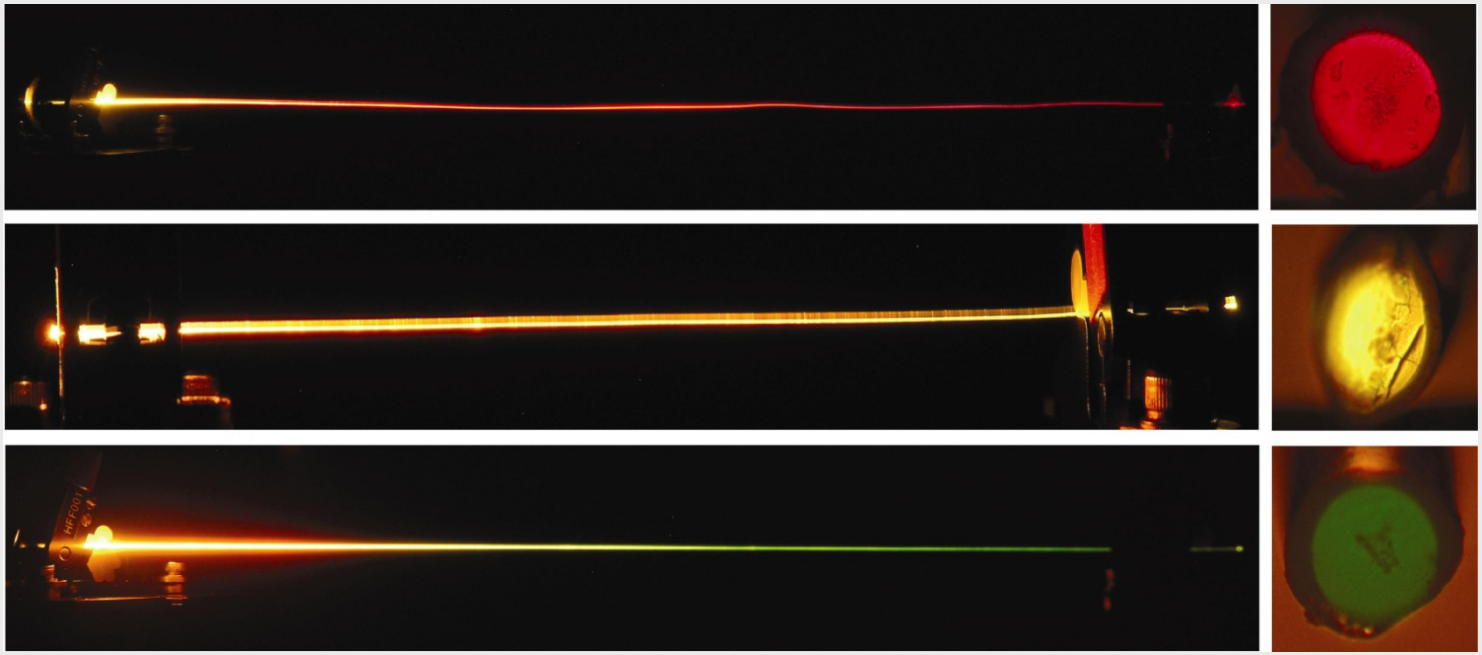


Emission of guided light

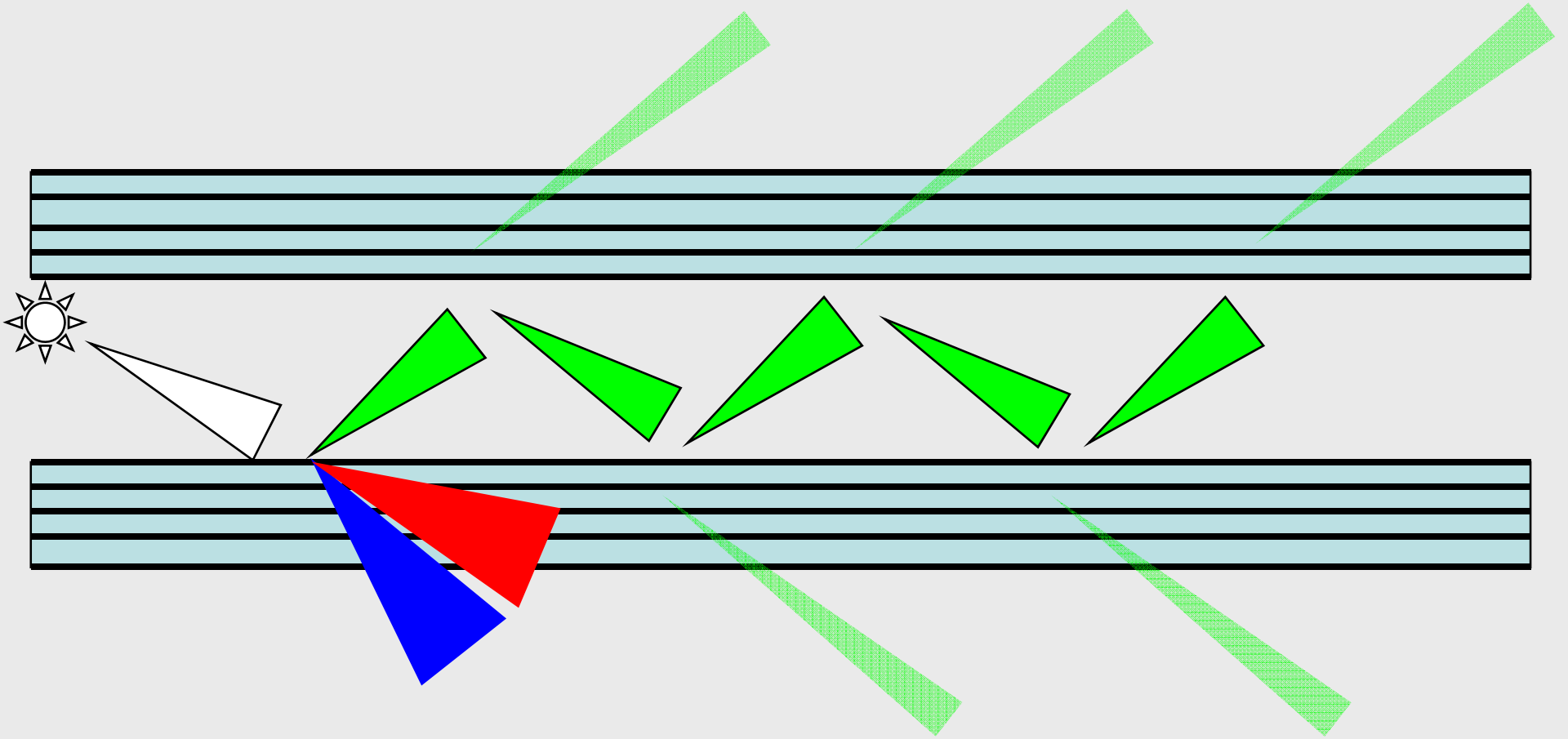
A. Dupuis, N. Guo, B. Gauvreau, A. Hassani, E. Pone, F. Boismenu, and M. Skorobogatiy, "Guiding in the visible with "colorful" solid-core Bragg fibers," Opt. Lett. **32**, 2882-2884 (2007).

Transmitted and emitted colors

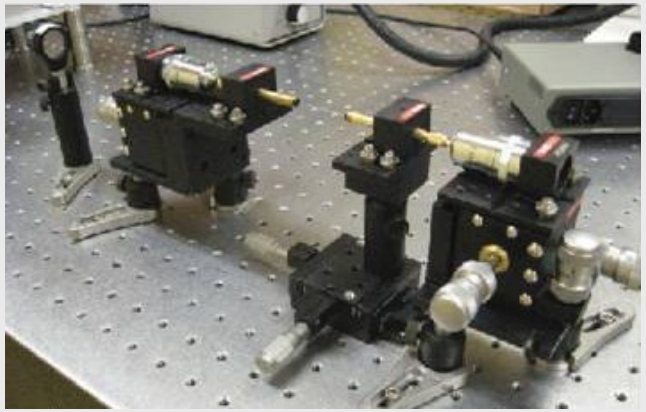


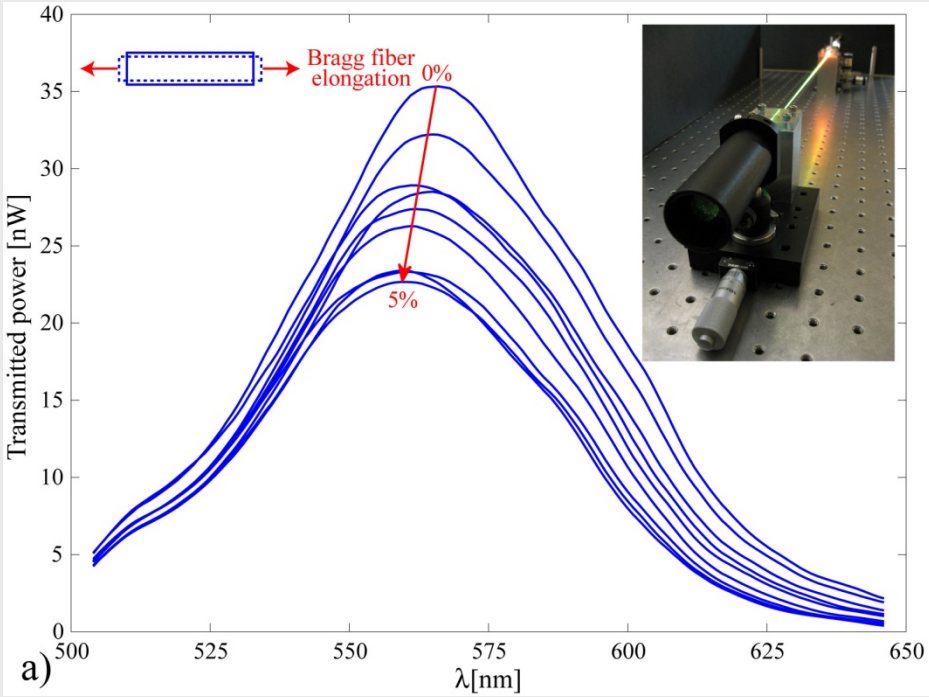


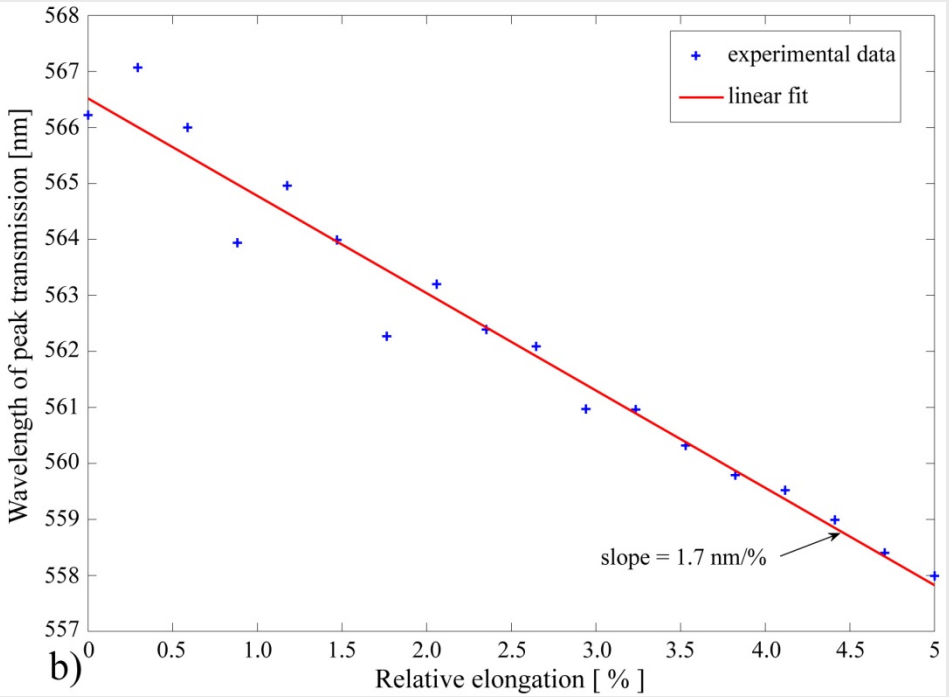
Why photonic crystal fibers are colored?



Bangap shift due to fiber elongation applications in sensing of strain



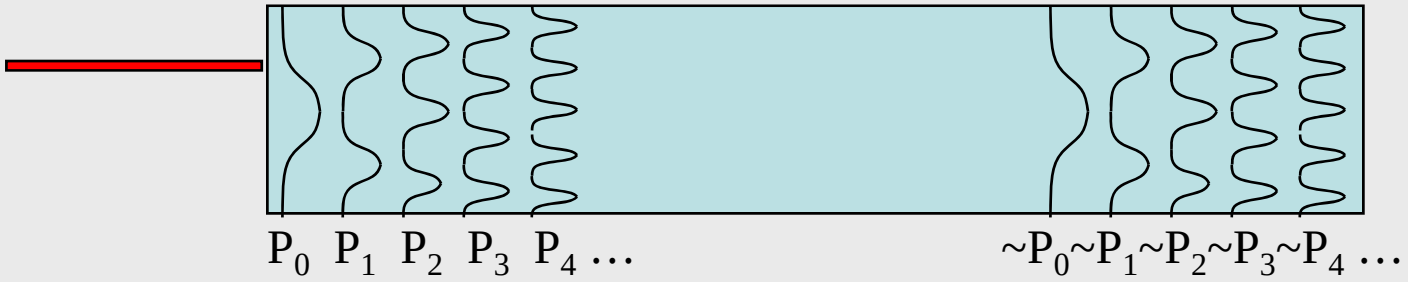




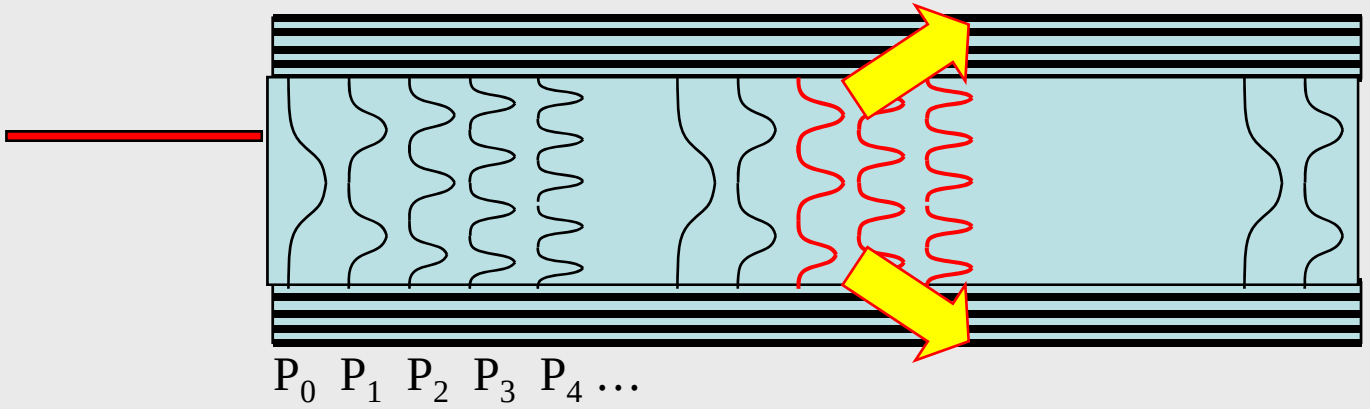
B. Gauvreau, N. Guo, K. Schicker, K. Stoeffler, F. Boismenu, A. Ajji, R. Wingfield, C. Dubois, M. Skorobogatiy, "Color-changing and color-tunable photonic bandgap fiber textiles," Opt. Express, Vol. 16, pp. 15677-15693 (2008).

Why Photonic Band Gap fibers are effectively single mode regardless of the core diameter?

In SI-TIR fibers almost all the modes lunched into the multimode fiber reach the fiber end with similar relative powers.

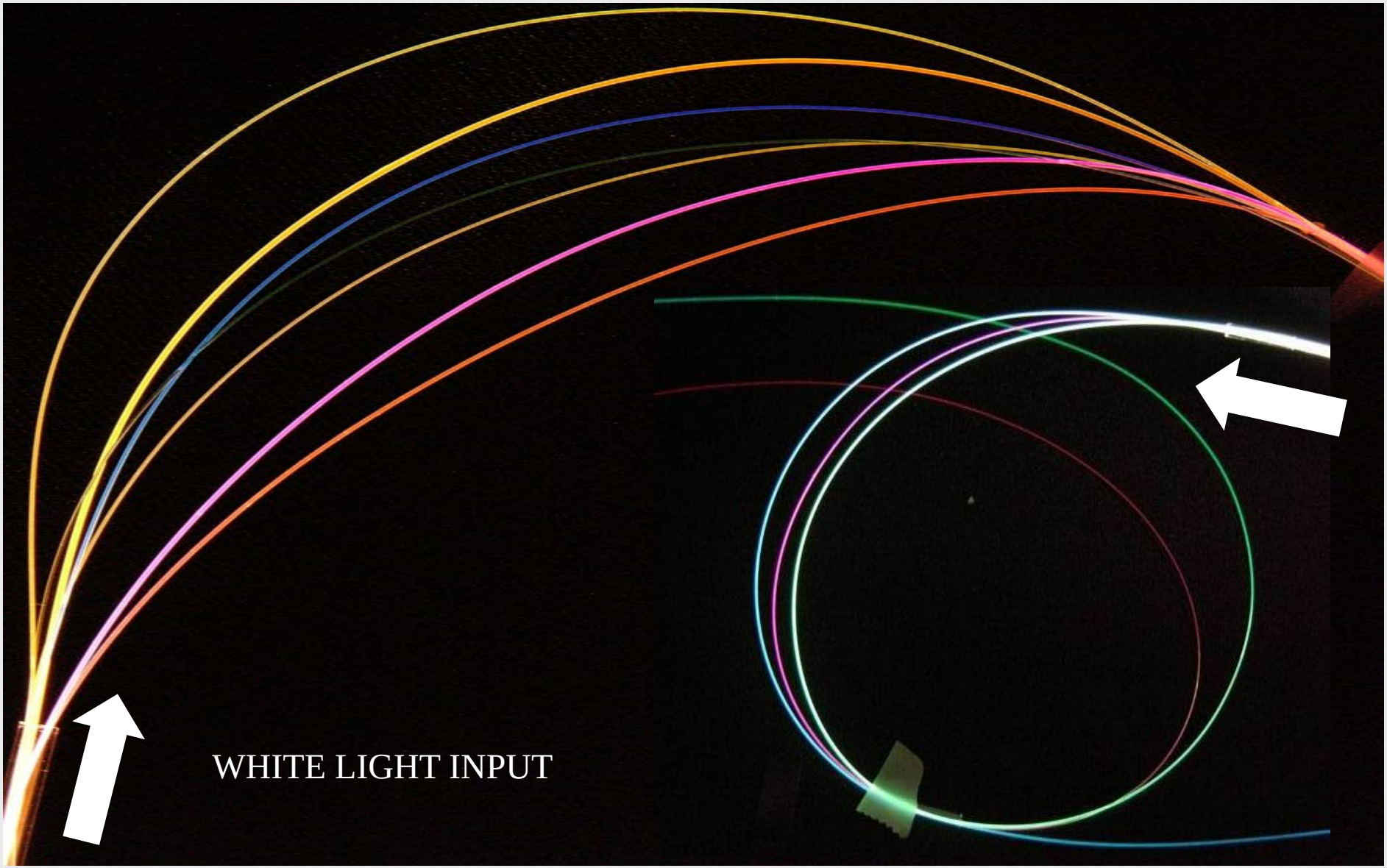


In Photonic Band Gap fibers only the lowest loss modes reach the fiber end.

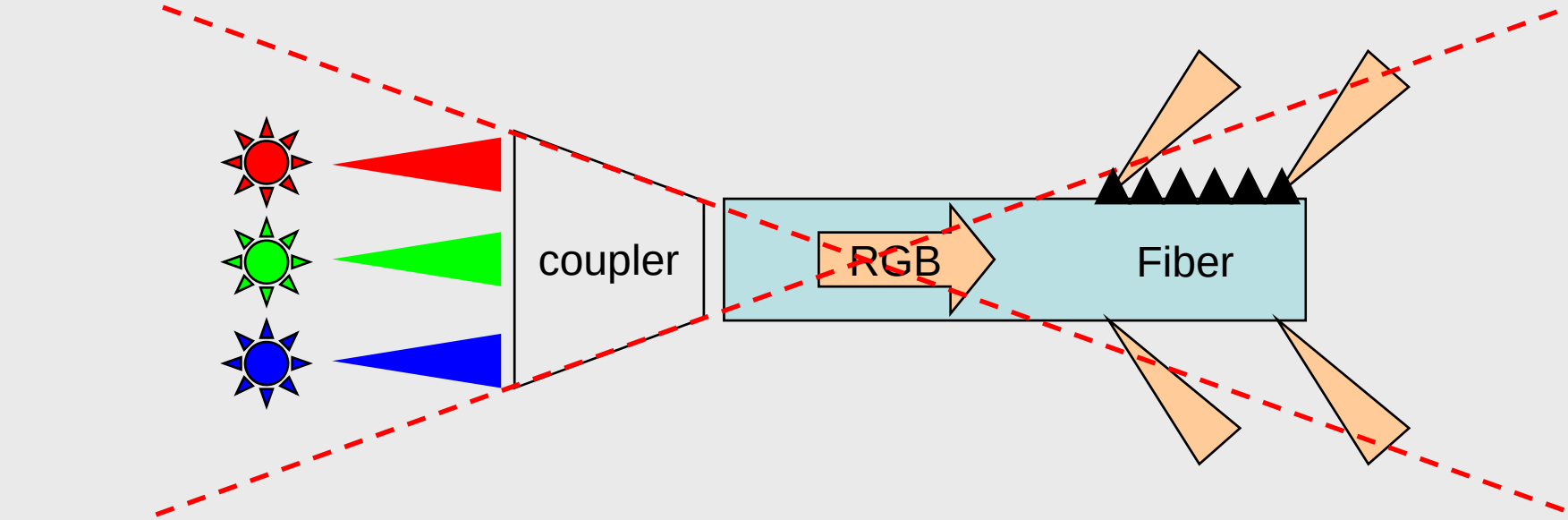


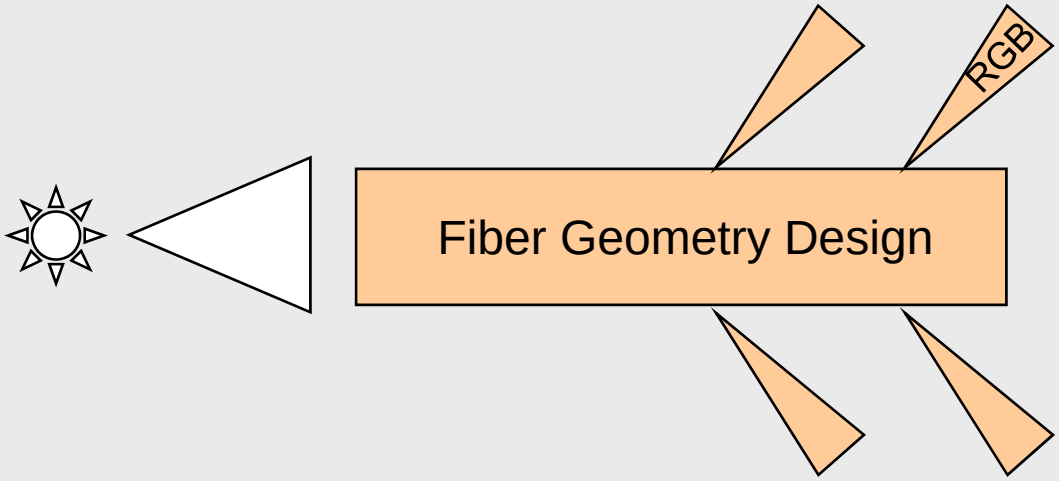
M. Skorobogatiy and N. Guo, “Bandwidth enhancement by differential mode attenuation in multimode photonic crystal Bragg fibers,” Opt. Lett., Vol. 32, p. 900 (2007).

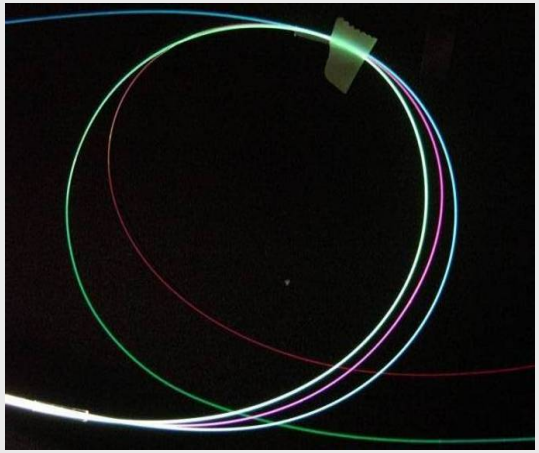
PBG fiber bundles application in colorful illumination



Color on demand by fiber geometry design
No mechanical perturbations for light extraction

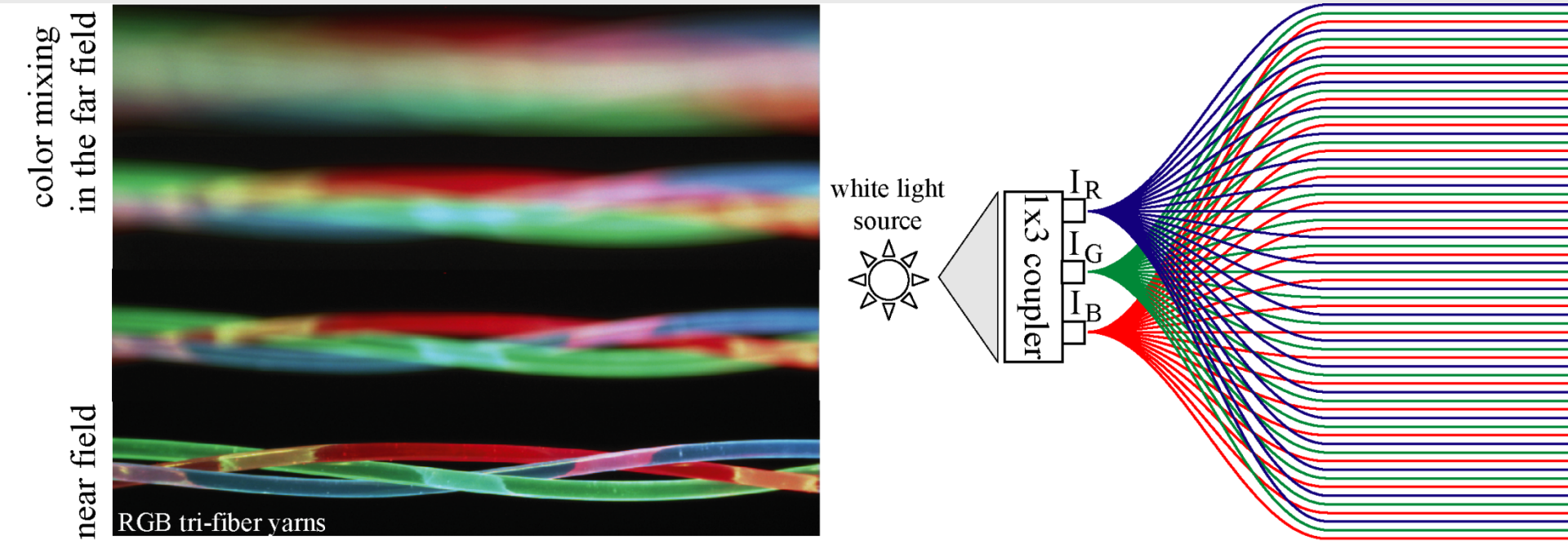




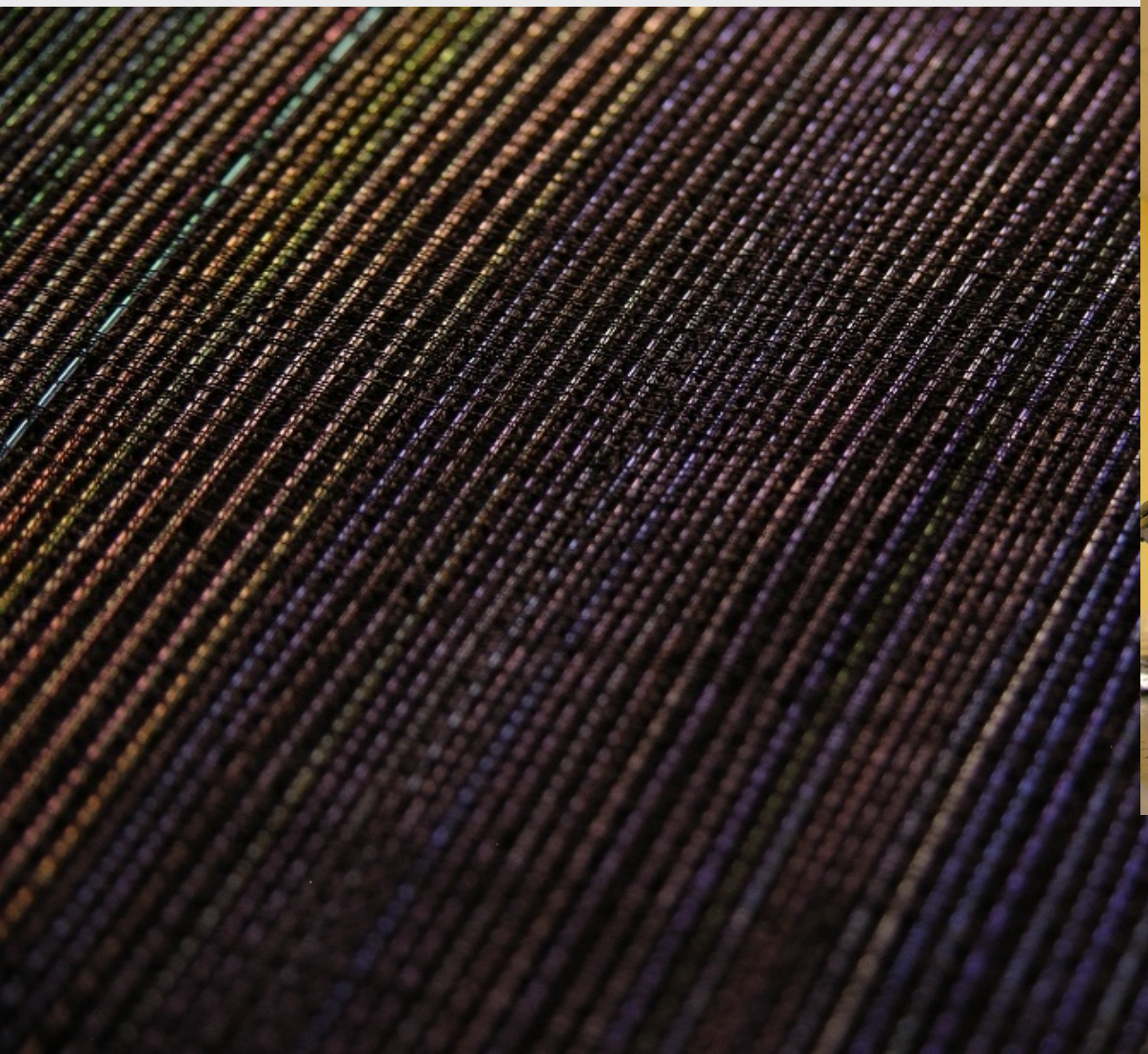


B. Gauvreau, N. Guo, K. Schicker, K. Stoeffler, F. Boismenu, A. Ajji, R. Wingfield, C. Dubois, M. Skorobogatiy, "Color-changing and color-tunable photonic bandgap fiber textiles," Opt. Express, Vol. 16, pp. 15677-15693 (2008).

Fusion of RGB colors for color changing textiles

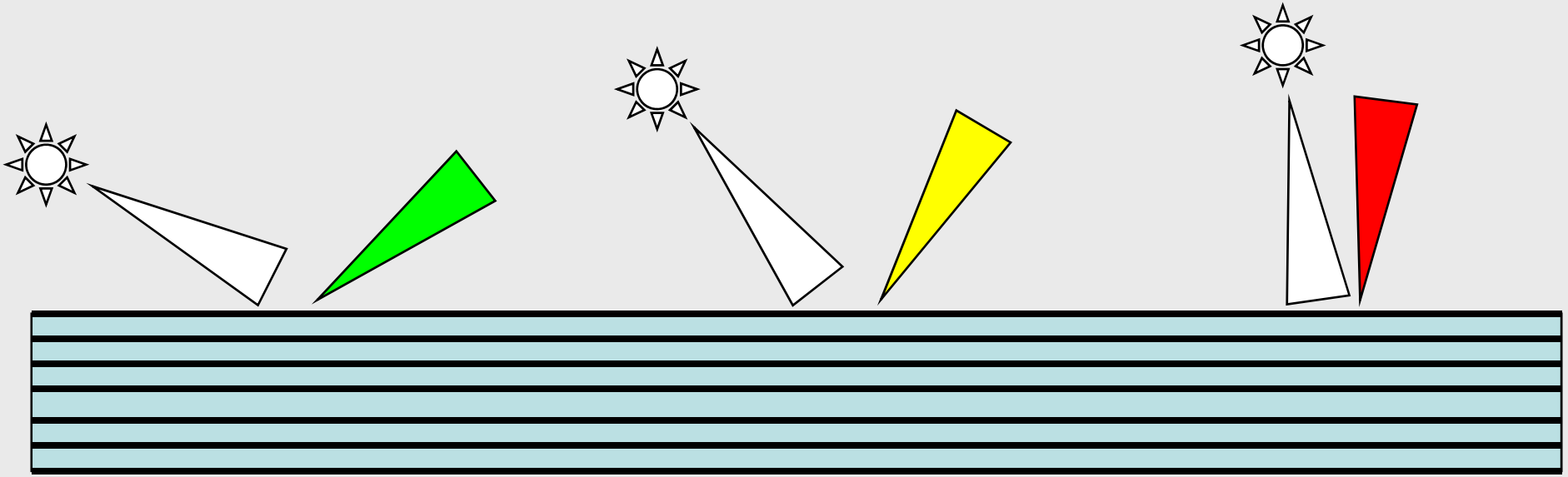


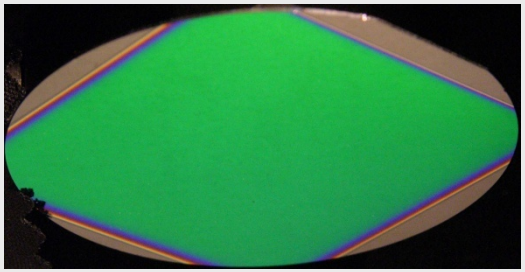
Fiber color in reflection (no guided light)



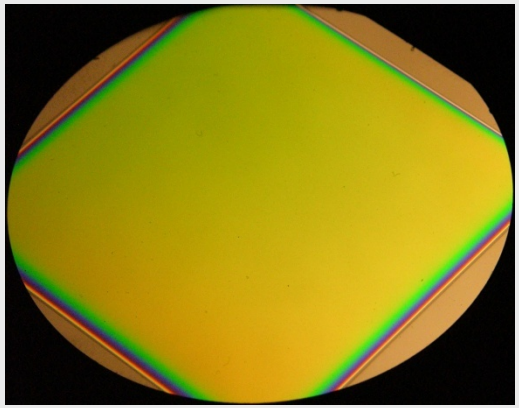
Fiber color in reflection (no guided light)

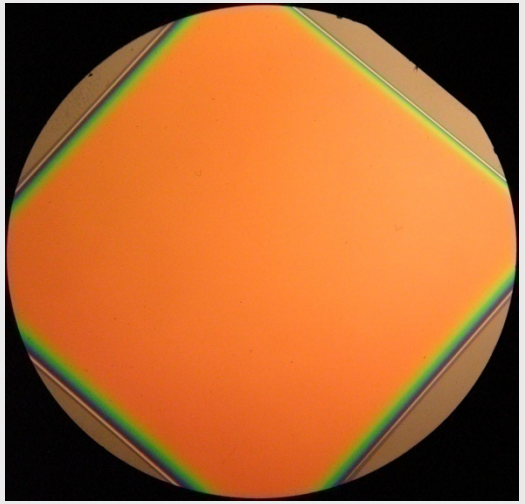
Dielectric multilayer “mirrors” have different colors when looked at different angles





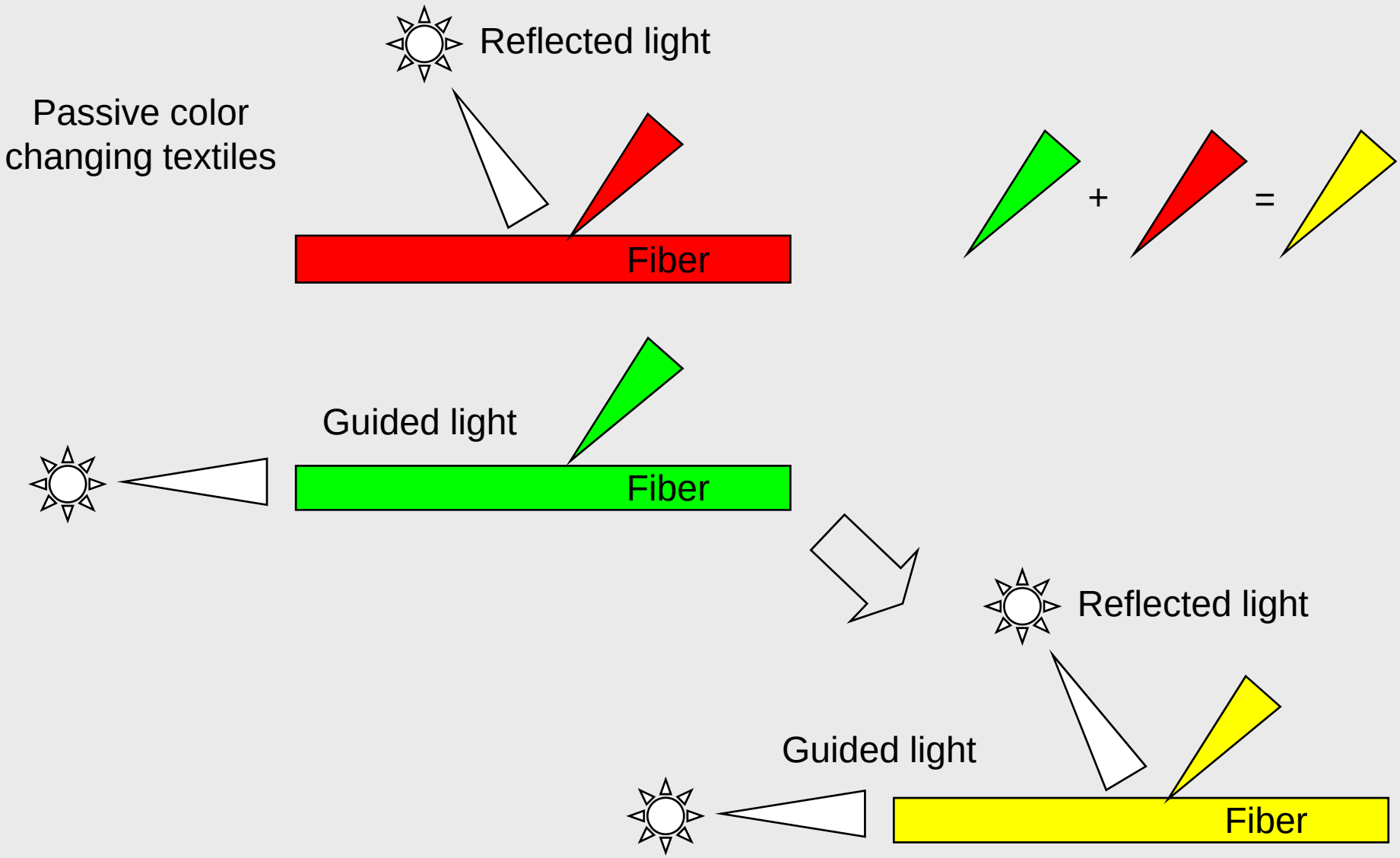
Fiber guiding regime





Outside reflection regime

Color changing textiles (passive technology)



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Color changing textiles applications in displays and camouflage

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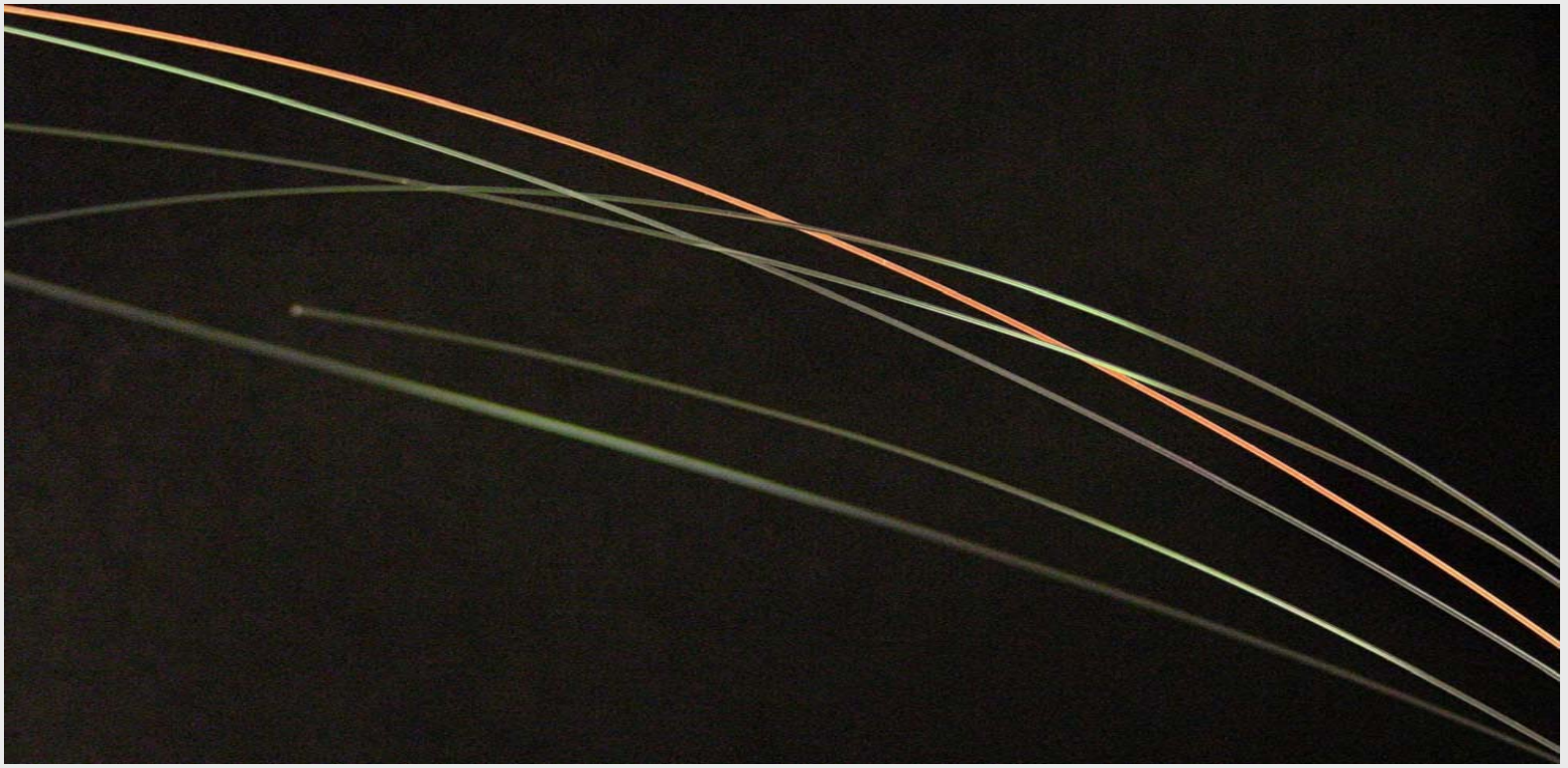
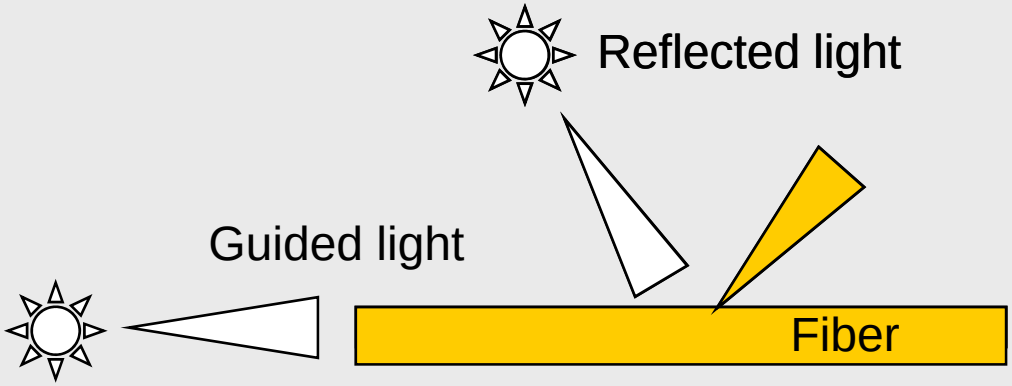
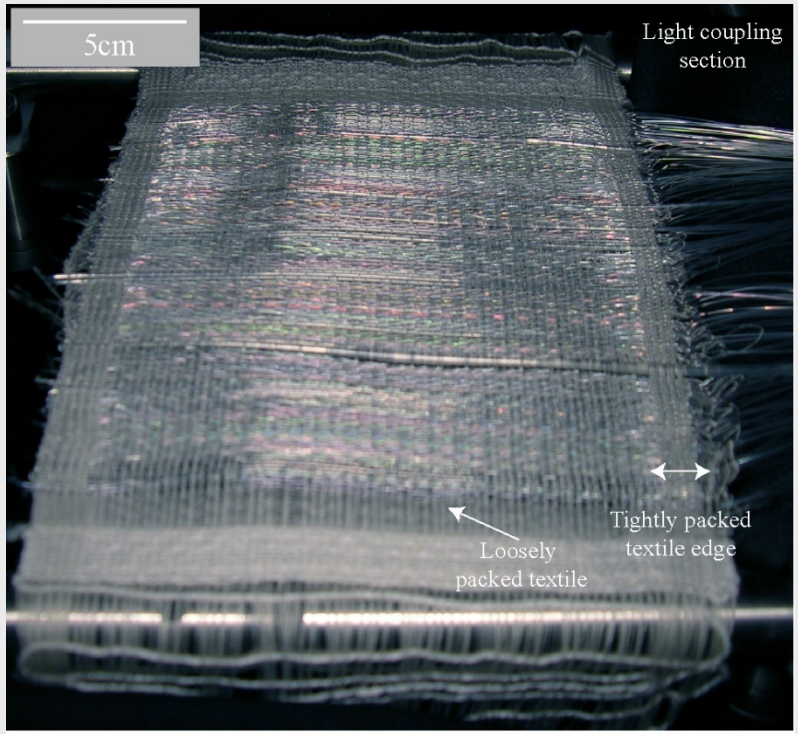
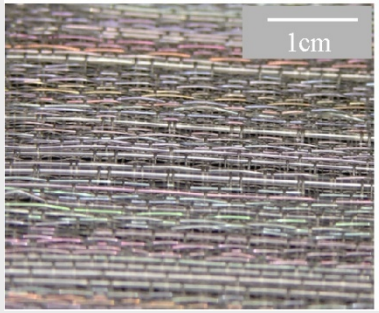
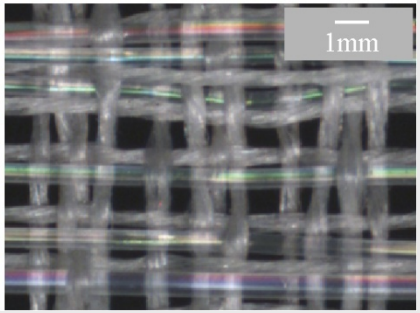


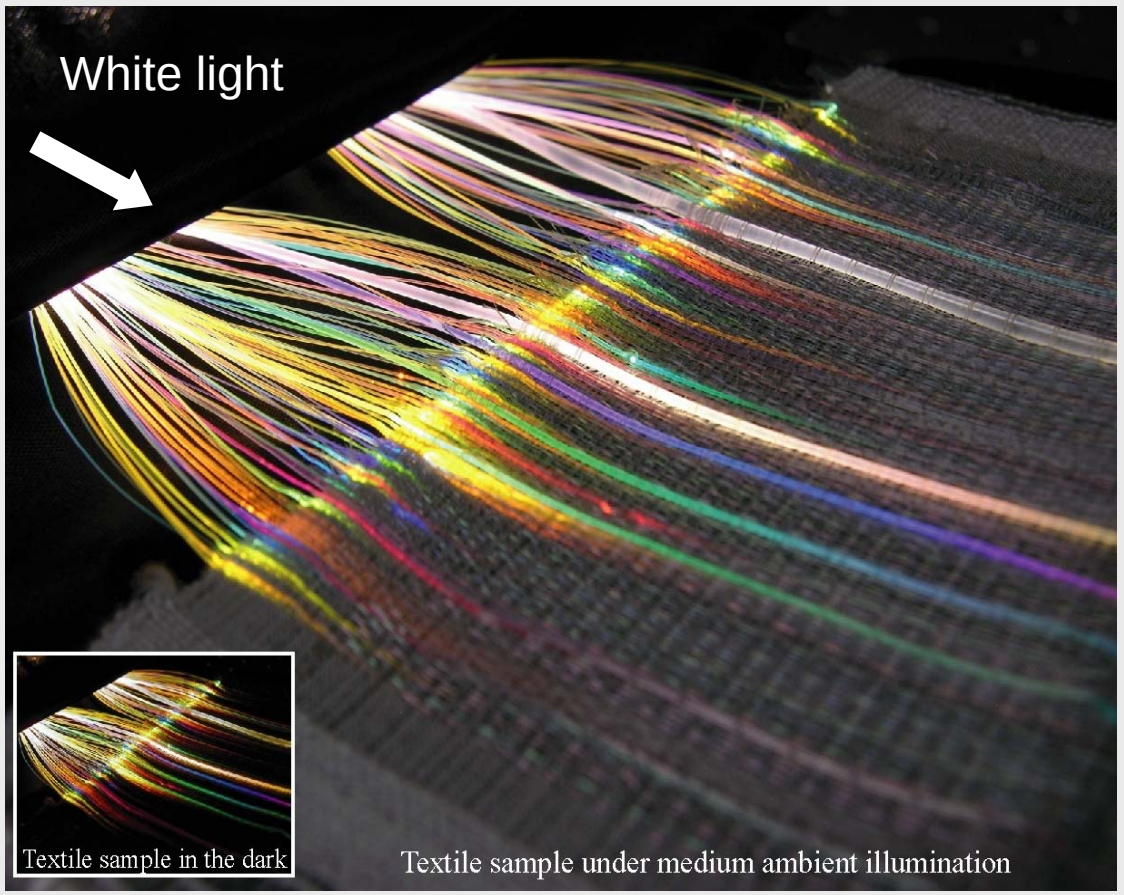


Thin (100-300um) Bragg fibers in a white silk matrix, prototype I





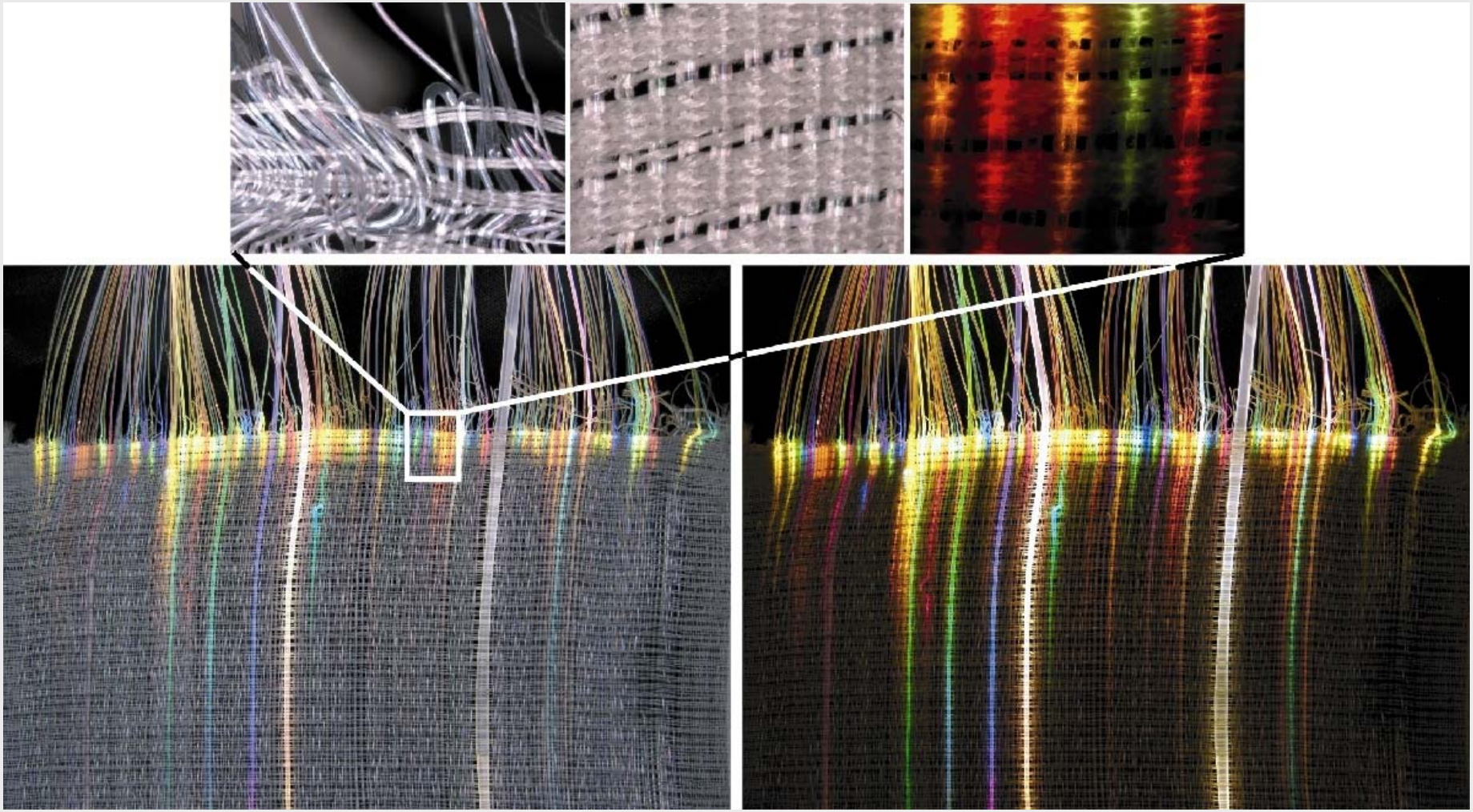




Textile colors in reflection and light emission are designable by the choice of a fiber geometry (white light illumination)

B. Gauvreau, N. Guo, K. Schicker, K. Stoeffler, F. Boismenu, A. Ajji, R. Wingfield, C. Dubois, M. Skorobogatiy, "Color-changing and color-tunable photonic bandgap fiber textiles," Opt. Express, Vol. 16, pp. 15677-15693 (2008).

Prototype I. Problems in coupling light



Nature Photonics - Colour-tunable textiles, News and Views, Nov. 2008

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Thicker (200-500um) Bragg fibers in a black silk matrix, prototype II

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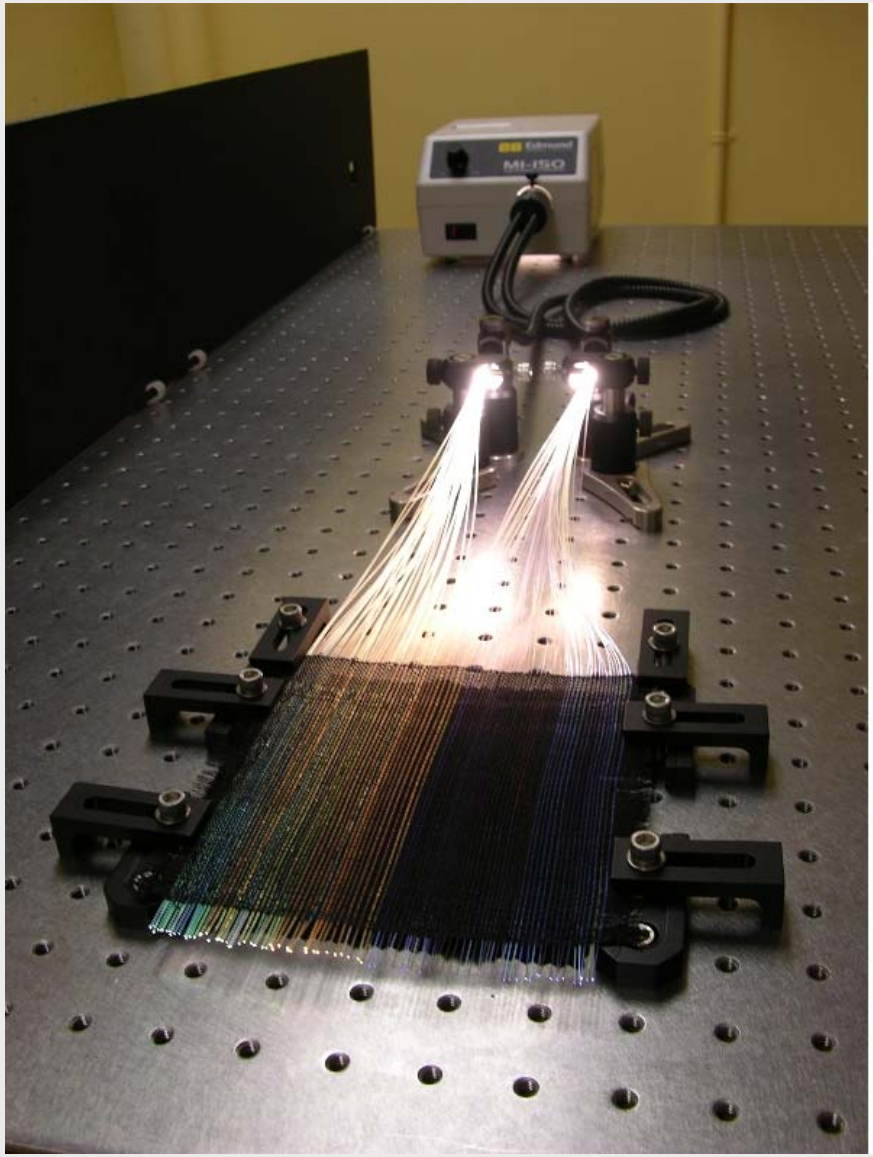
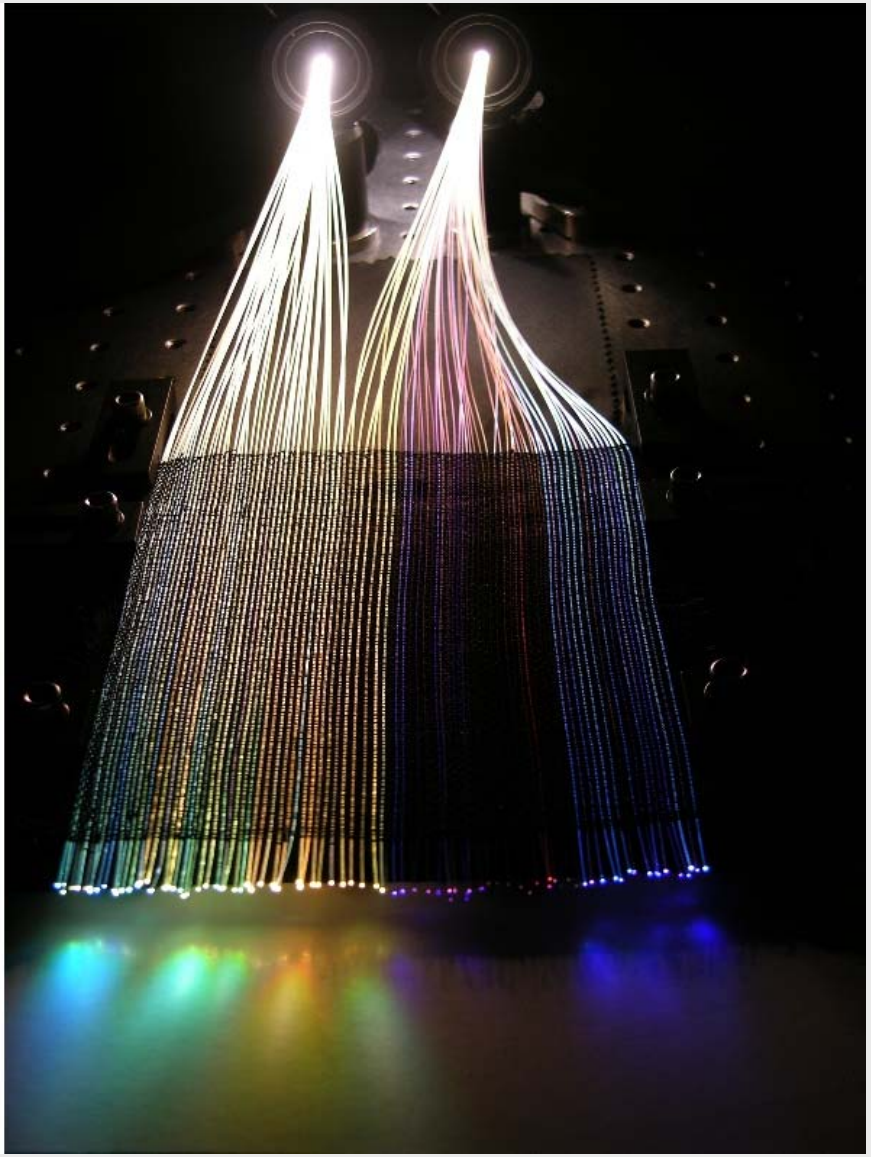
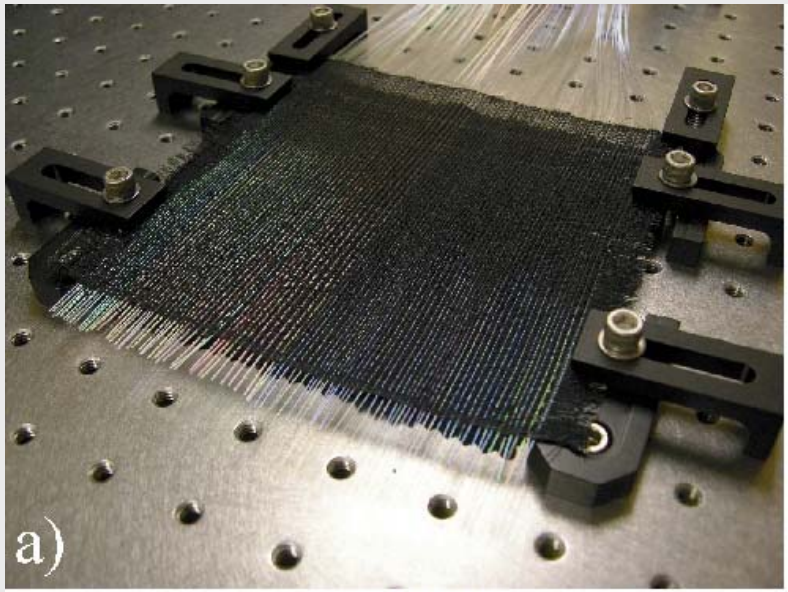
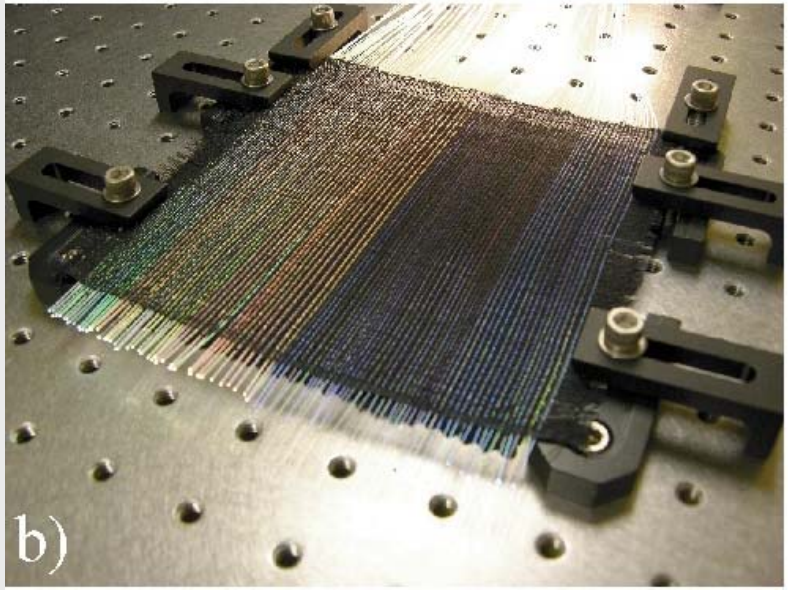
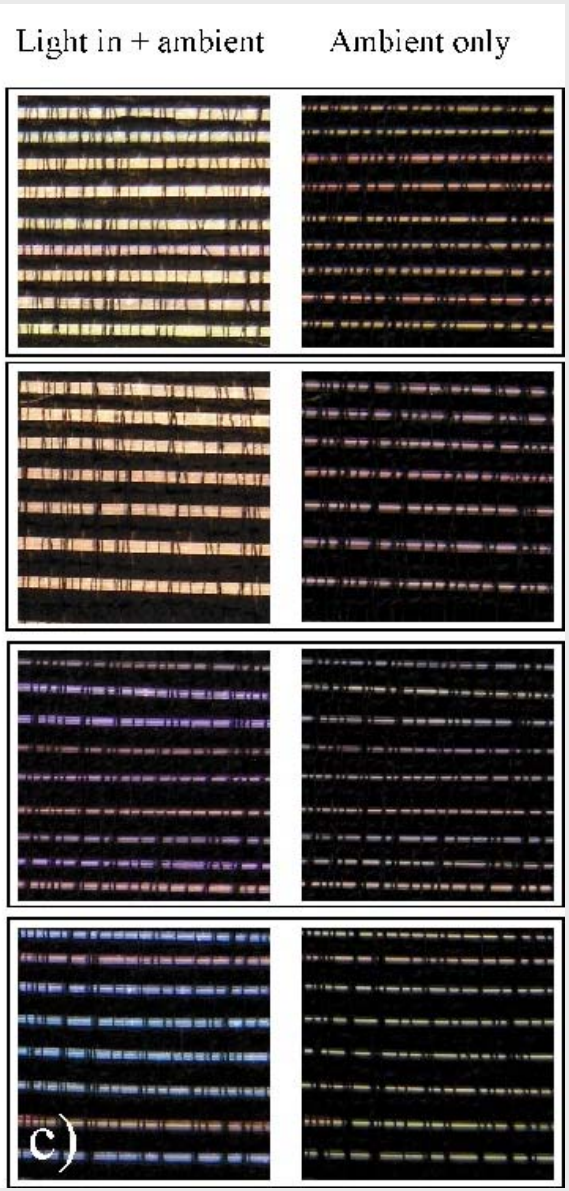




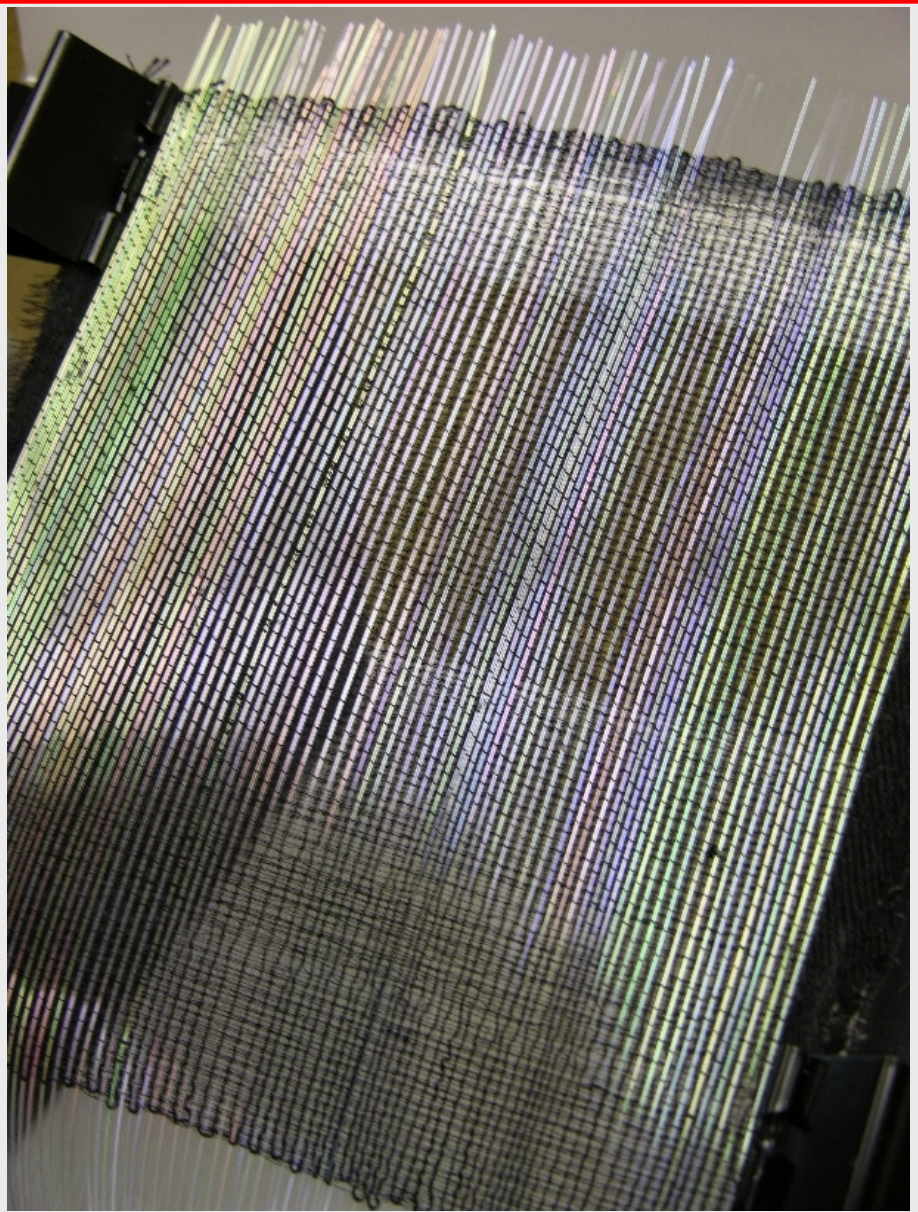
Prototype II. Color changing functionality





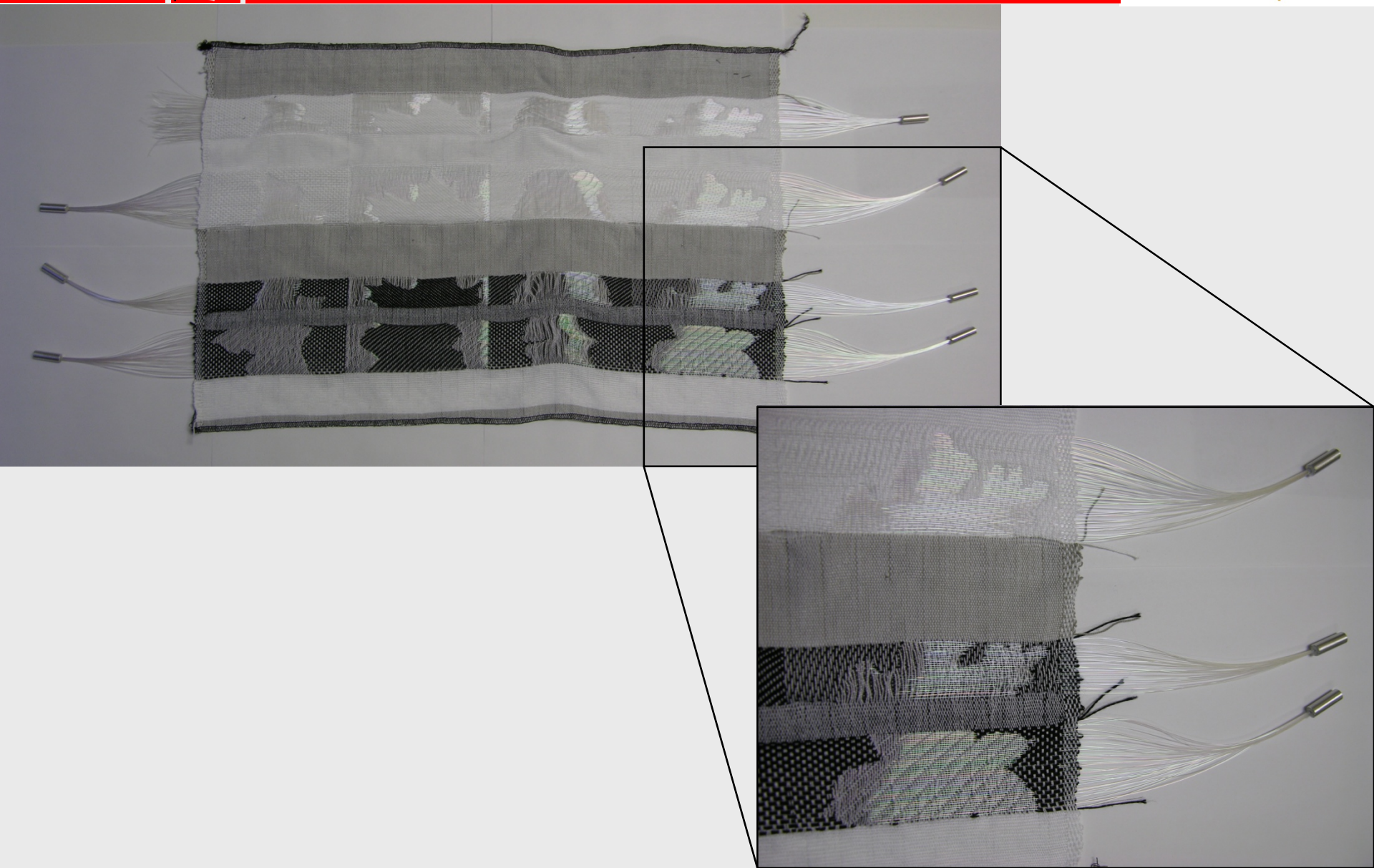


Prototype II. Reflection of ambient light (no guided light)



Prototype III. Implementing patterns using Jacquard loom

Karma Chameleon project with the Hexagram center J. Berzowska, Concordia University



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Prototype III. Reflection of directed light (no guided light)

Karma Chameleon project with the Hexagram center J. Berzowska, Concordia University

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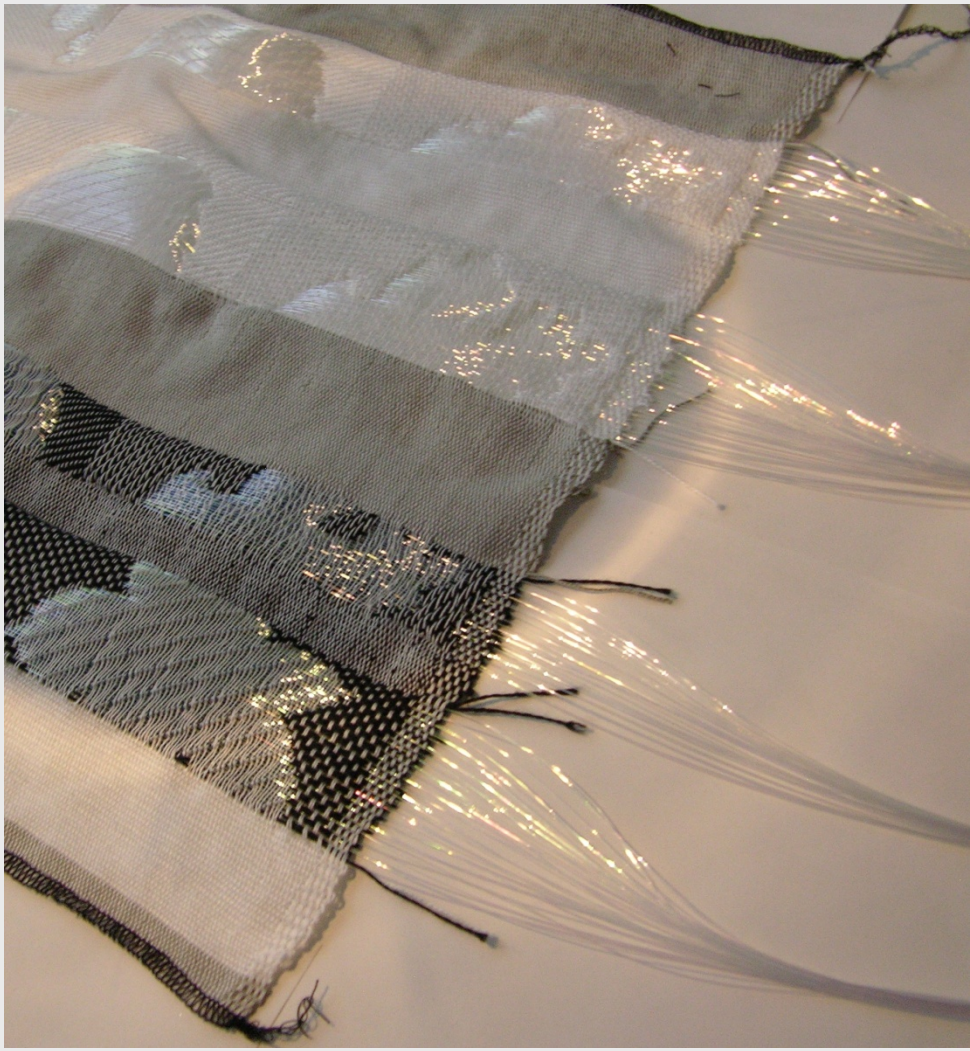

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Prototype III. Emission of guided light

Karma Chameleon project with the Hexagram center J. Berzowska, Concordia University

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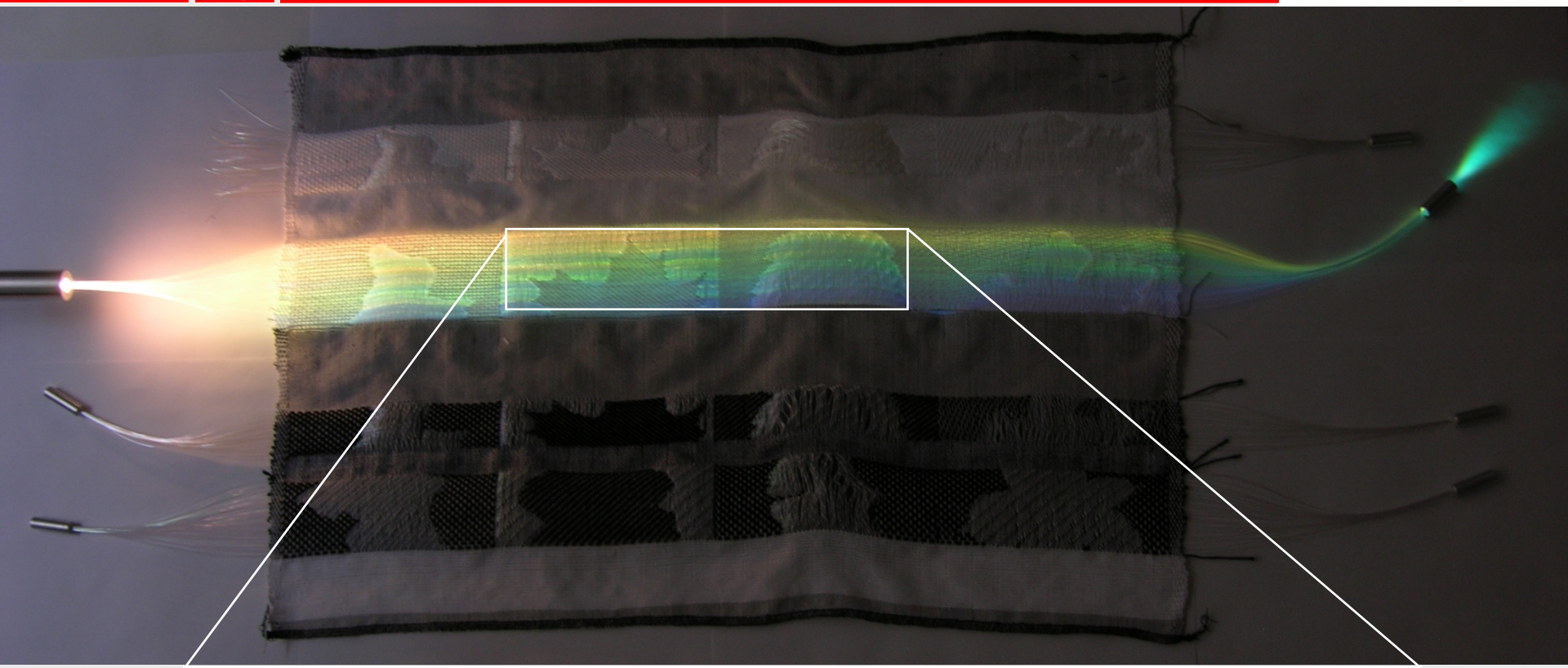

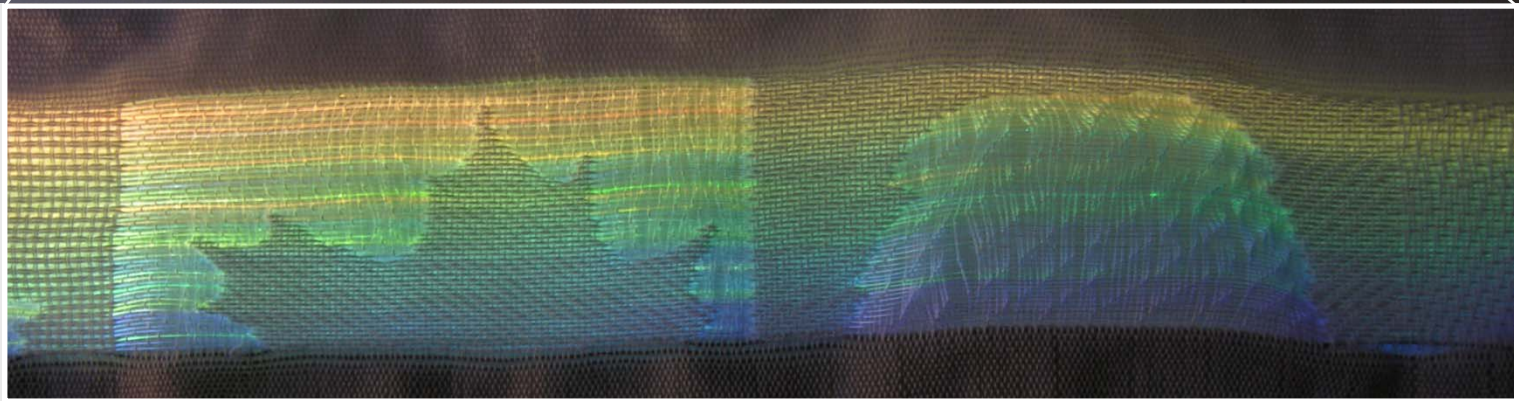

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Prototype III. Emission of guided light. Switching patterns

Karma Chameleon project with the Hexagram center J. Berzowska, Concordia University

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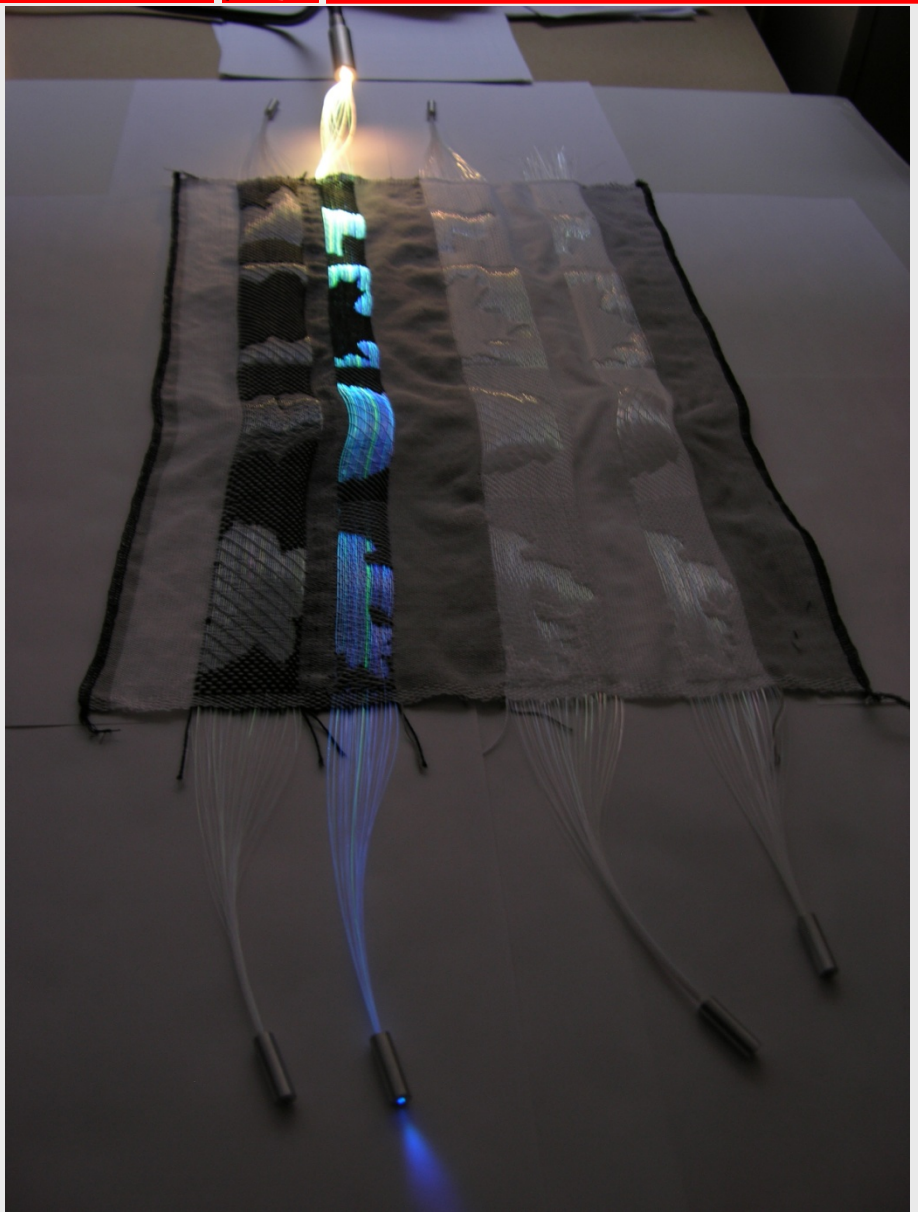

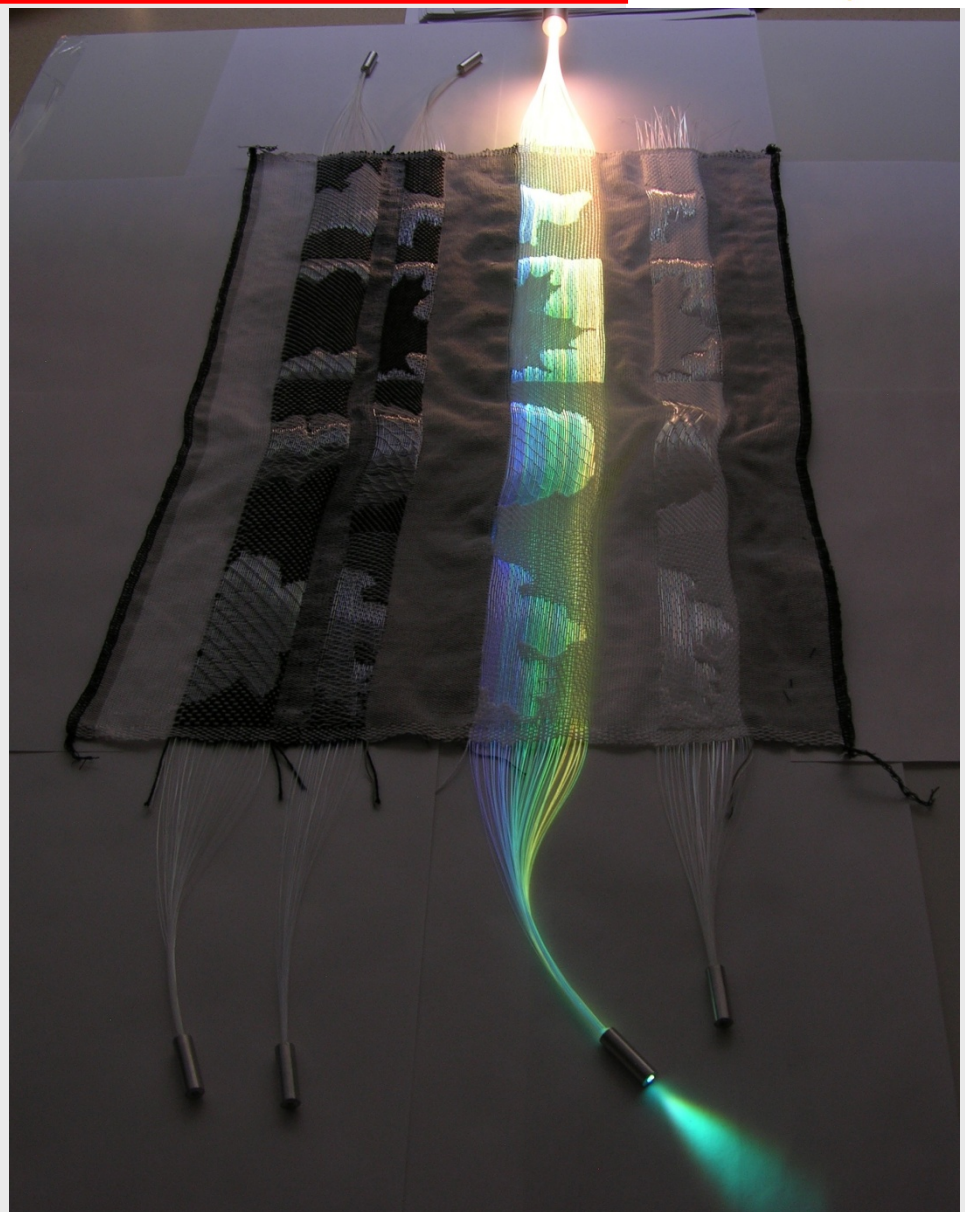

Summary of Photonic Bandgap Textiles

- As Photonic Bandgap fibers guide light in the low refractive index core by photonic bandgap effect they naturally emit sideways a portion of guided color without the need of mechanical perturbations, which is highly advantageous for illumination applications.
- We have demonstrated Bragg fibres that reflect one color when side illuminated, and emit another color while transmitting the light. We then showed that by controlling the relative intensities of the ambient and guided light the overall fibre color can be varied.
- General implementation of the color-on-demand textiles using RGB yarns in the form of tri-fiber braids was discussed. It was established that another key advantage offered by PBG fibers in application to photonic textiles is stability of the emitted color over time.
- Finally, compared to other existing PBG fibers, all-plastic Bragg fibres currently offer the most economical solution required by the textile applications.
- Potential in distributed sensing and high bandwidth telecommunications with multimode fibers was also demonstrated

Thank you

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