EMPA

Materials Science & Technology

Medical Applications of Textiles Containing Optical Fibers

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Outline

- Empa
- Overview Luminous Textiles
- Optical Fibers in Textiles
- Medical Applications
- Outlook

Empa – Materials Science and Technology

- 125 Years ago founded on behalf of industry
- Over 800 employees
- Part of the ETH domain
- Department of Materials & Systems for Protection & Wellbeing of the Body
  - Protection and Physiology
  - Functional Fibers and Textiles
  - Biocompatible Materials

Section Medical Textiles

- Cooling garment for Multiple Sclerosis patients
- Pad for poorly curative wounds
- Textiles for decubitus prevention
- Luminous textiles for light therapy

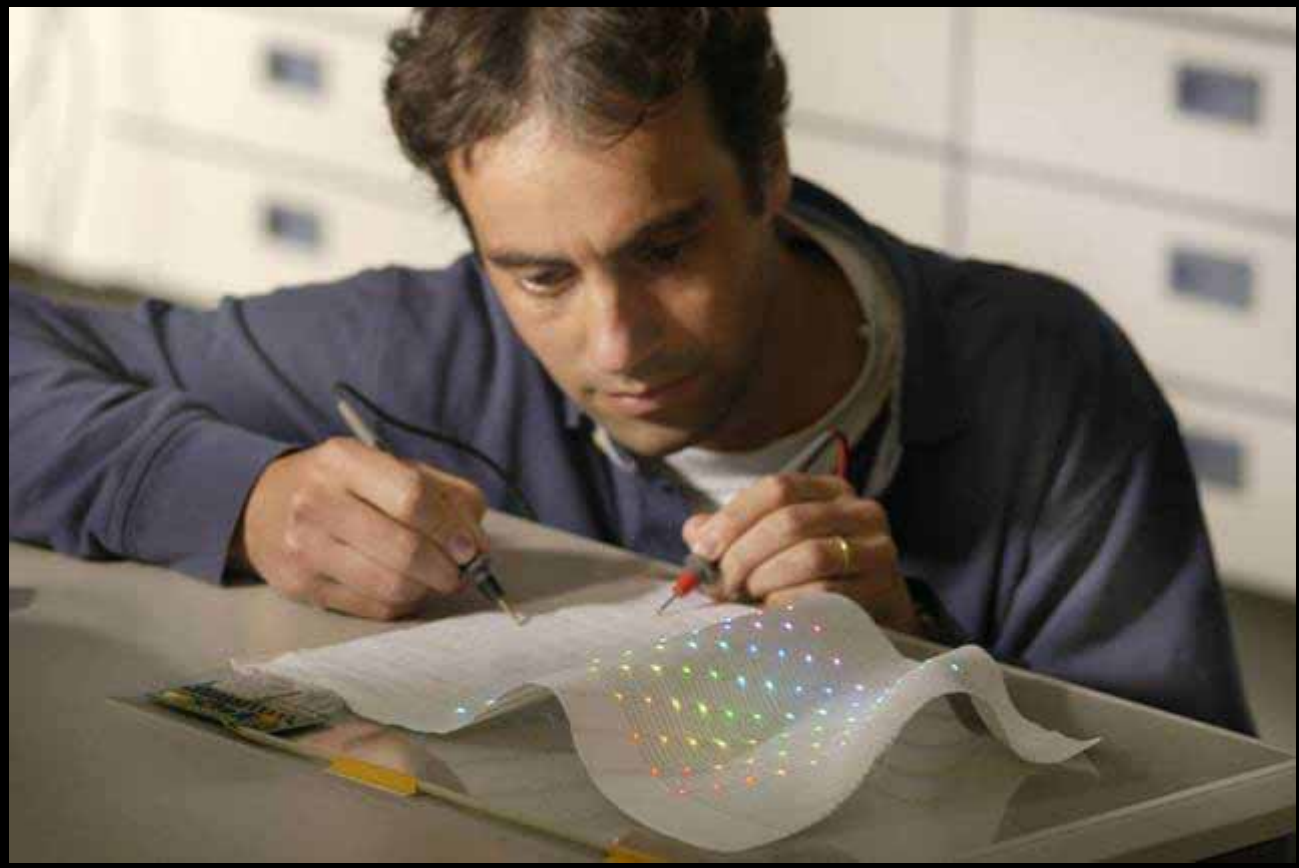


Textiles and Light – Employment

- Fashion, design
  - Clothing
  - Accessories
- Signaling
  - Kids jackets, backpacks
- Illumination
  - Automotive industry
- Medical technology

Light Emitting Diodes (LEDs)

Philips Research



Light Emitting Diodes (LEDs)

Philips Research

Light Emitting Diodes (LEDs)

Philips Research

Electroluminescent Foils

Loop

Electroluminescent Foils

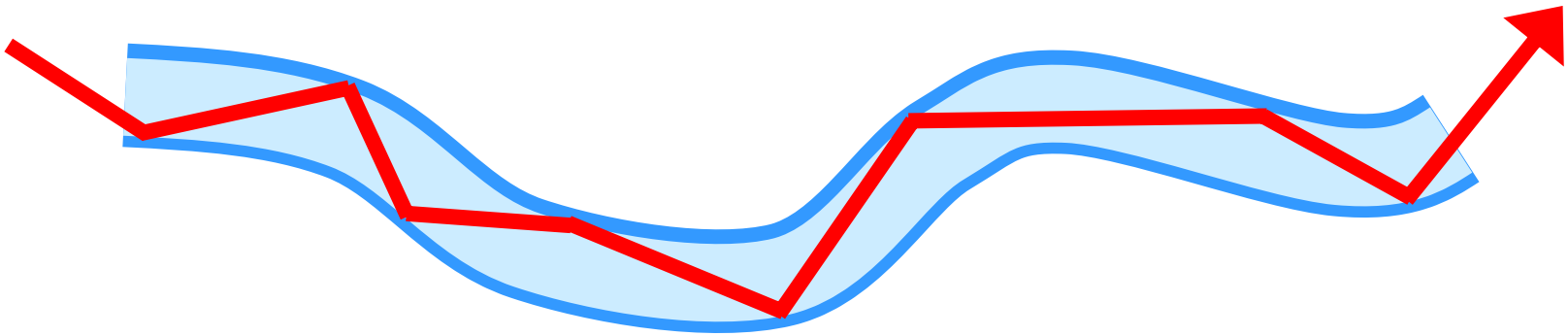
Loop

Electroluminescent Foils

Loop

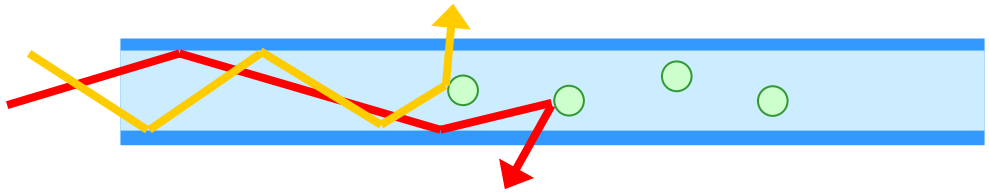
Plastic Optical Fibers (POF)

- Waveguide for light → optical data communication, telecommunication
- Polymeric material (PMMA)
- Different refraction index of polymeric core and cladding (or air) leads to total light reflection

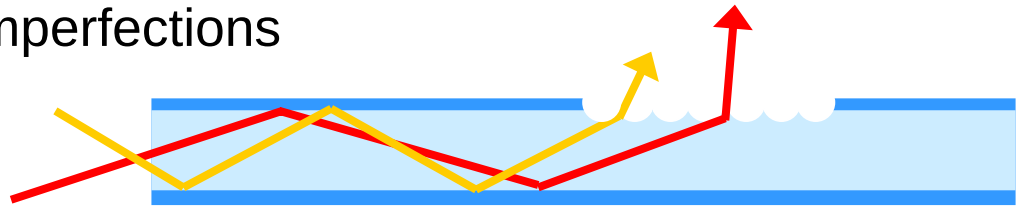


Light Emitting POFs

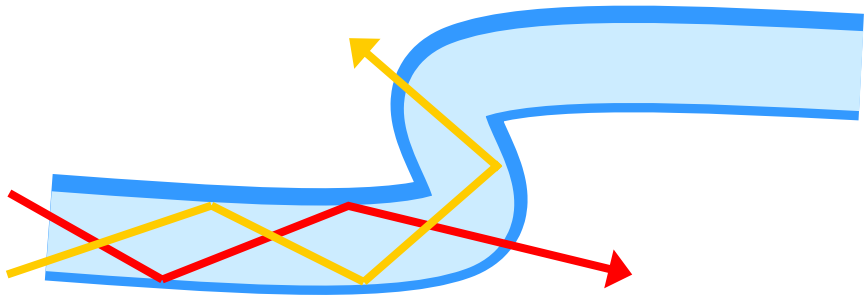
Particles (Scattering, Luminescence)



Cladding imperfections



Sharp bends



Woven Side Emitting POF

Luminex

Woven Side Emitting POF

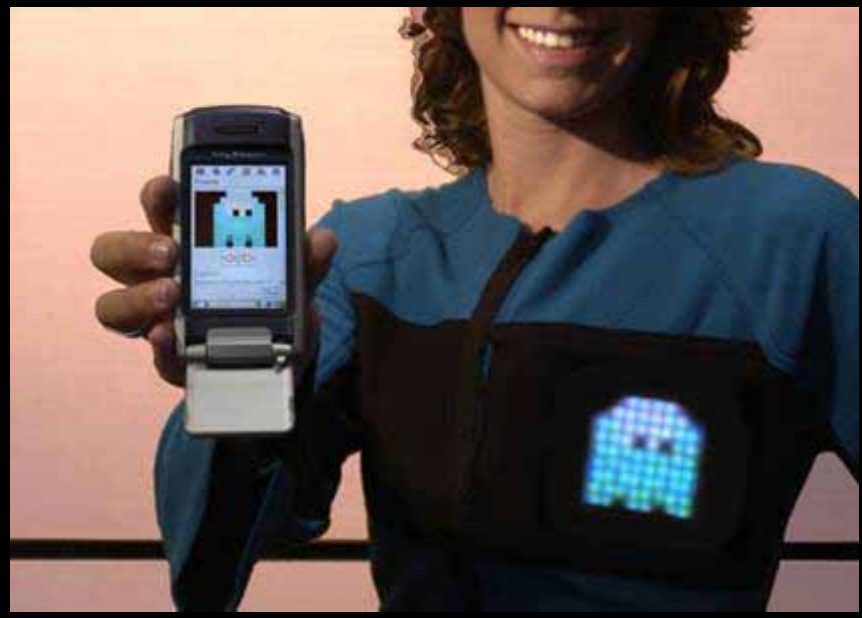
Luminex

Woven Side Emitting POF

Luminex

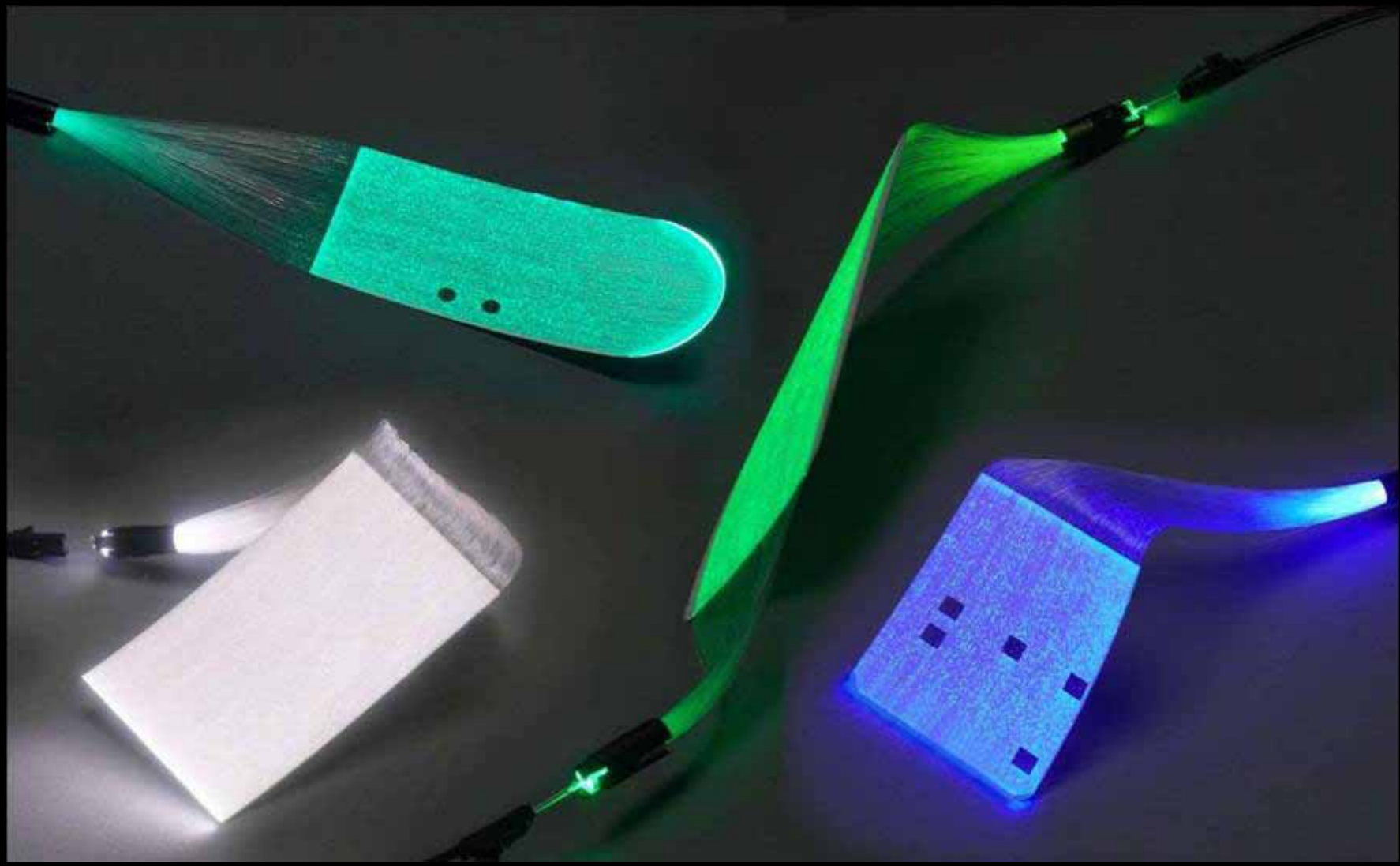
“Blouson Communicant” – LED and POF

France Telecom



Woven POF Fabric

Lumitex



Woven POF Fabric

Lumitex

Woven POF Fabric

Lumitex

Weft Knitting of POFs

stfi

What Makes Optical Technology Attractive for Medical Applications

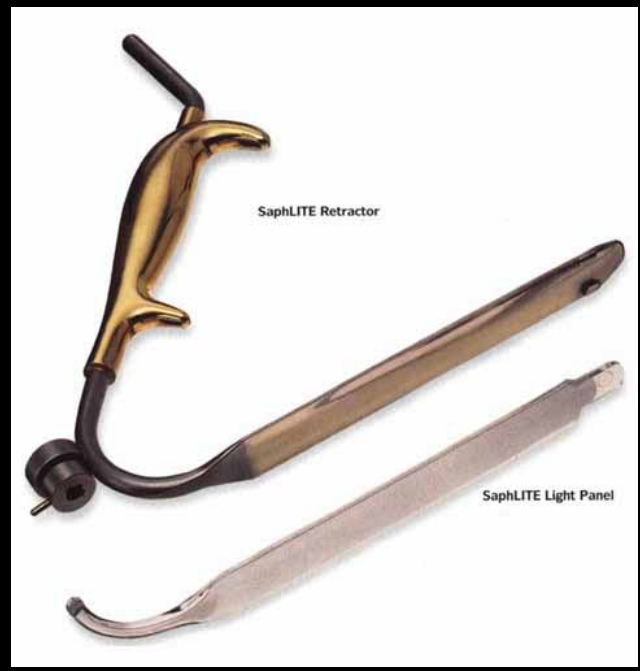
- Immune to electromagnetic interference
- Small in size
- Easily embedded in a variety of composite and textile materials without compromising the host structures
- Can be mass-produced in low cost

Medical Application – Data Communication

Wearable Motherboard - Georgia Tech

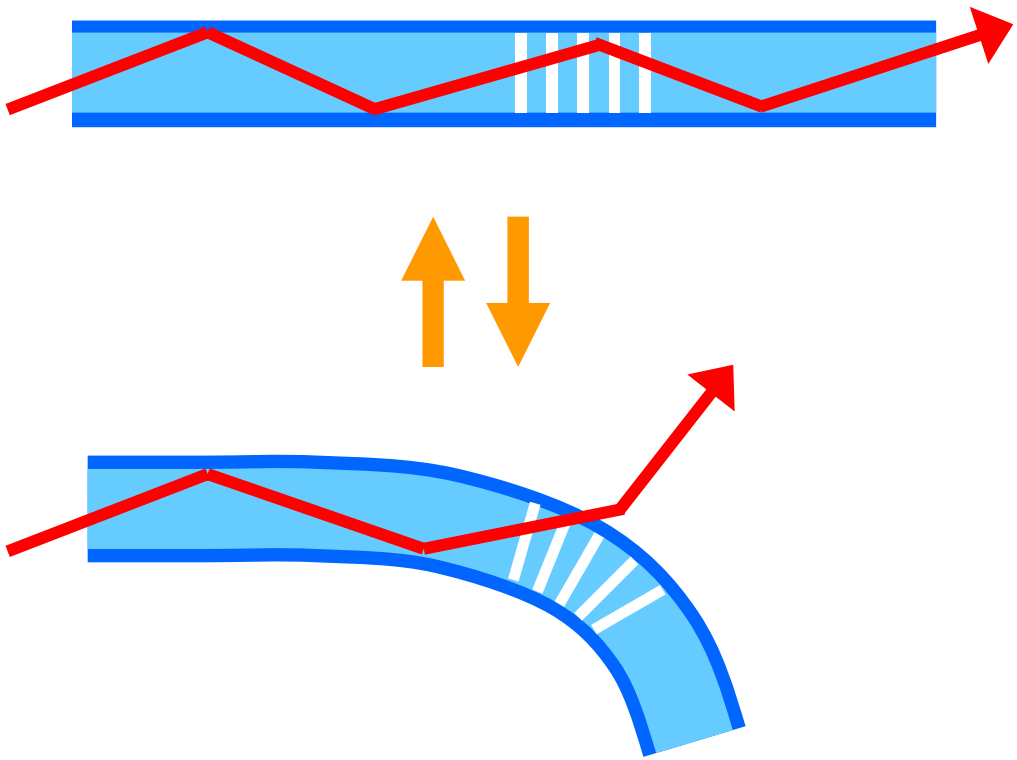
Medical Application – Illumination

Lumitex - LightMat



Medical Application – Sensors

Bragg Grating Fiber Optic Sensor



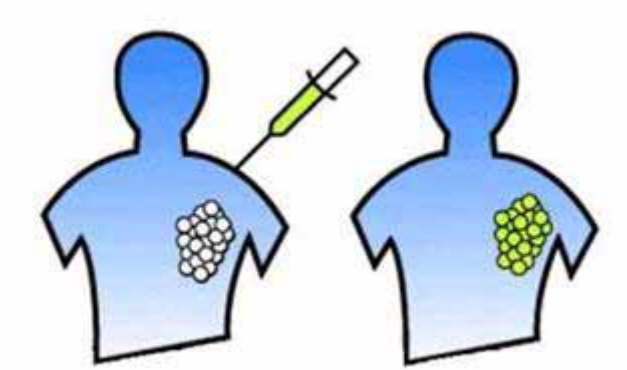
Detection of:

- Strain
- Bending
- Motion
- Load distribution
- Temperature

Medical Application at EMPA

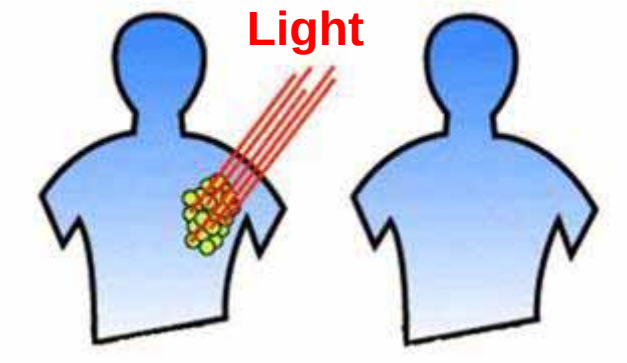
Photodynamic Cancer Therapy (PDT)

1. Dye is injected into the body



2. Dye concentrates at the tumor site

3. Dye is activated by light

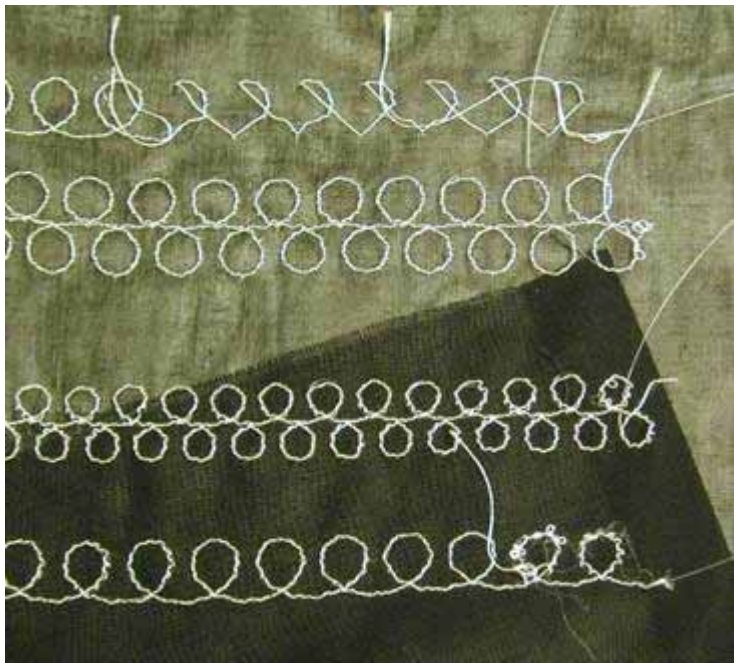


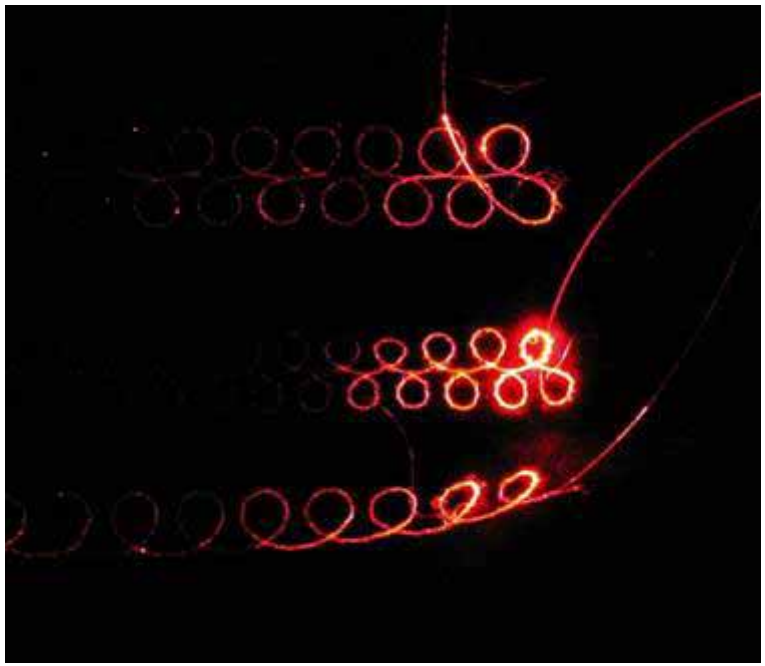
4. Tumor is selectively destroyed

Light Diffusor for Photodynamic Therapy

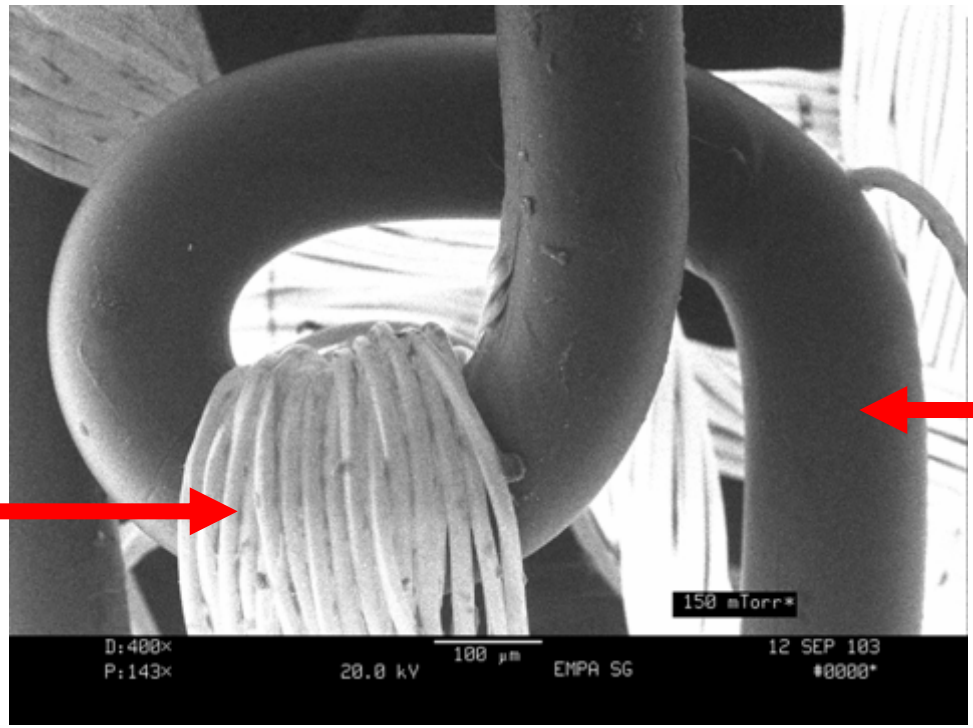
- Challenge
  - Flexible light diffusor for body cavities
- Requirements
  - Luminous emittance only where needed
  - No additional manufacturing process
- Solution
  - POF processed by embroidery

Micro Bends lead to Luminous Emittance





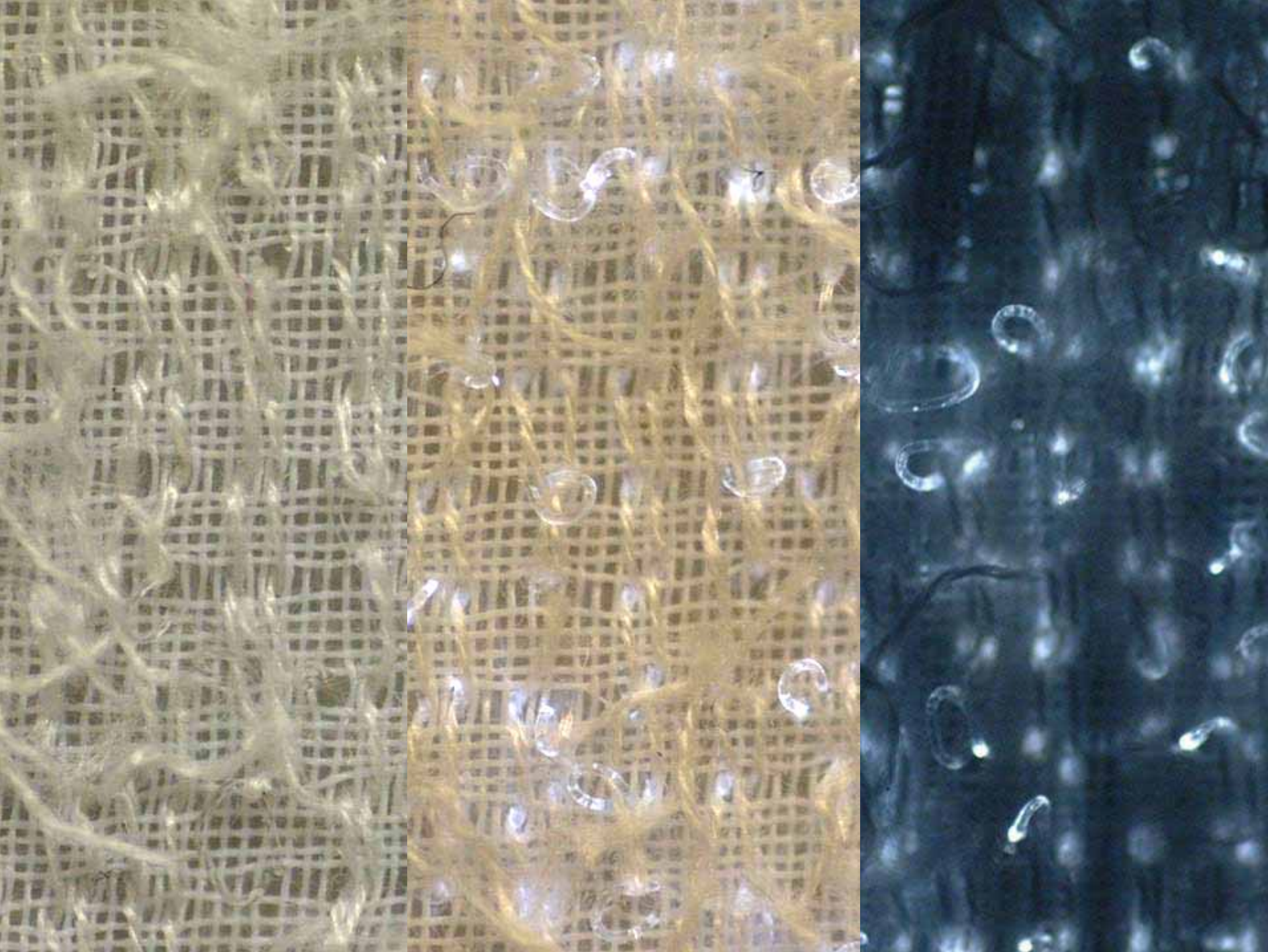
Embroidery of POF



Embroidery thread

Optical Fiber

0.5 mm



Results

- ☺ Embroidery of thin POF is practicable
- ☺ Luminous emission is controllable during manufacturing process
- ☺ A thin and flexible light diffuser of any geometry and size is producible

- ☹ Homogeneity

Future:
A light diffusor is also a light detector!?

- Diffusor and sensor capabilities in one unit
- Measurement of scattered light through tissue and tissue color or spectroscopy might be possible

➔ Wearable devices, incorporating optical textile technology, for monitoring and diagnosing vital functions of the human body

➔ Co-operations welcome!

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Thank you!

Further information

www.photomedizin.ch