Woven Electrodes for Optoelectronic Devices

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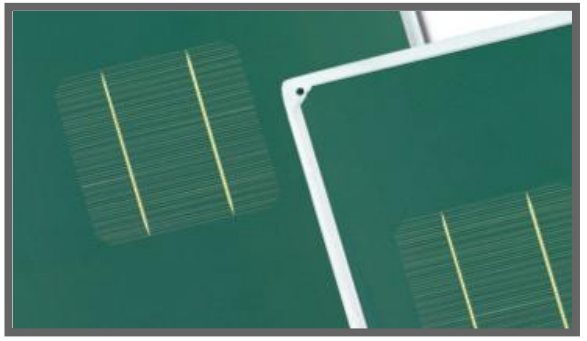
Woven Electrodes for Optoelectronic Devices

Actual SEFAR business

- Sefar's core skills is the manufacture and market of fabrics with precise mesh openings for screen printing and filtration processes
- Additional application: architecture, medicine and components
- Annual sales ~360 million CHF and 2000 employees worldwide

Actual application of SEFAR fabrics in solar and electronic industry

- Screen printing of various circuit boards
- TiO_2 printing in DSC or printing of CIGS
- Printing of front and back electrical contacts on Si solar cells



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New application of SEFAR® fabric

- **As transparent flexible electrode (substrate) in optoelectronic industry (as replacement of ITO coated foils)**

- **The fabric have following properties:**
  - **highly transparent and very conductive**
  - **after coating impermeable for liquids and gases**
  - **more flexible and mechanically stabile than foils**
  - **allowing preparation of shaped (fabrics reinforced) objects**

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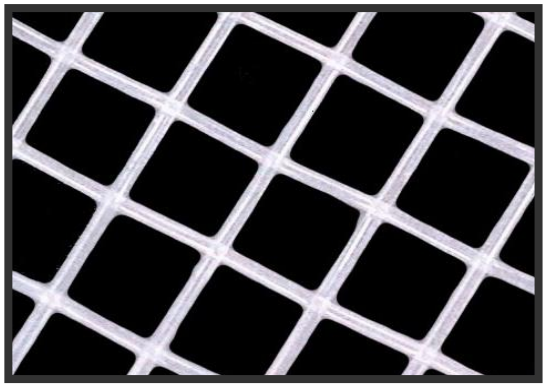
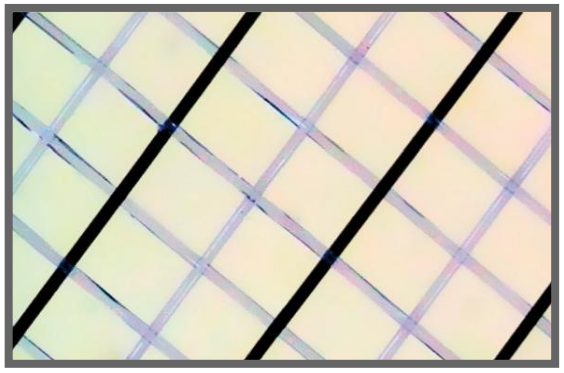
1. **The fabrics are made from synthetic fibers (PET, PA, PEN,…) with precisely defined large openings (70-80 % open areas)**

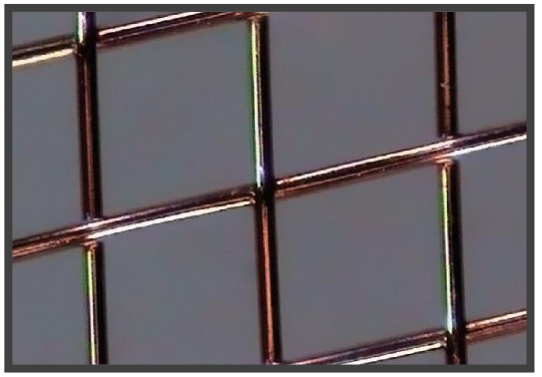


I. **The direct light transmission is dependent on the percentage of open area**

II. **Scattering of the light on fibers surfaces - significant increase of the whole transmissivity**

2. **The fabrics are conductive at least in one direction (< 1 Ω/sq)↔ reached either by using conductive fibers (wires) or by fabric metallization**





Lower resistance than ITO – Ohmic loss decreased when coming from a small cell to a large module

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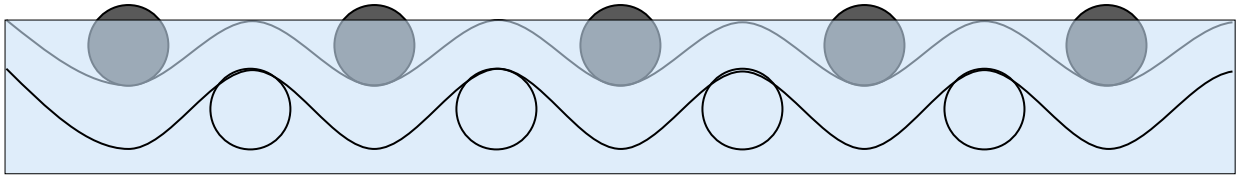
Coating parameters of Sefar flexible electrodes

3. **Fabrics are coated with very high transparent (cross linked) polymer layers - thickness is controlled in such a way that the substrate is still conductive from one side, but non-conductive from another side**



- **Coating protects any flow out of liquid optoelectronic components**
- **The coatings are generated from viscous liquids and after application cured by UV irradiation or thermally**
- **After curing, films are smooth and pinhole-free on submicron length scales (encapsulating processes in electronic devices)**

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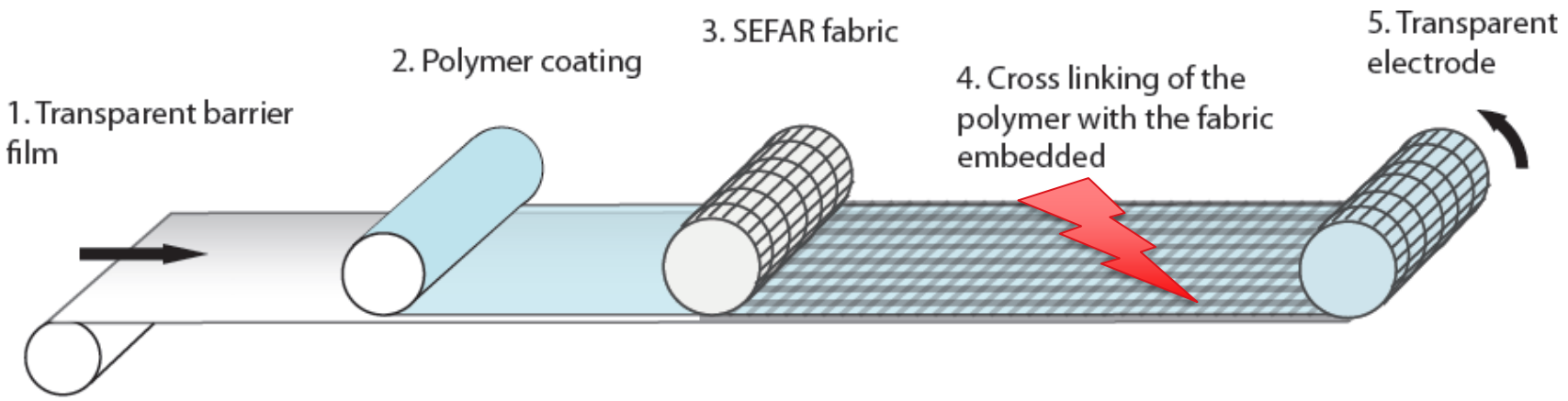
Production steps of Sefar flexible electrodes



Patent pending PCT/EP 2009/007894 (DE 10 2008 055969.5, Nov. 5, 2008)

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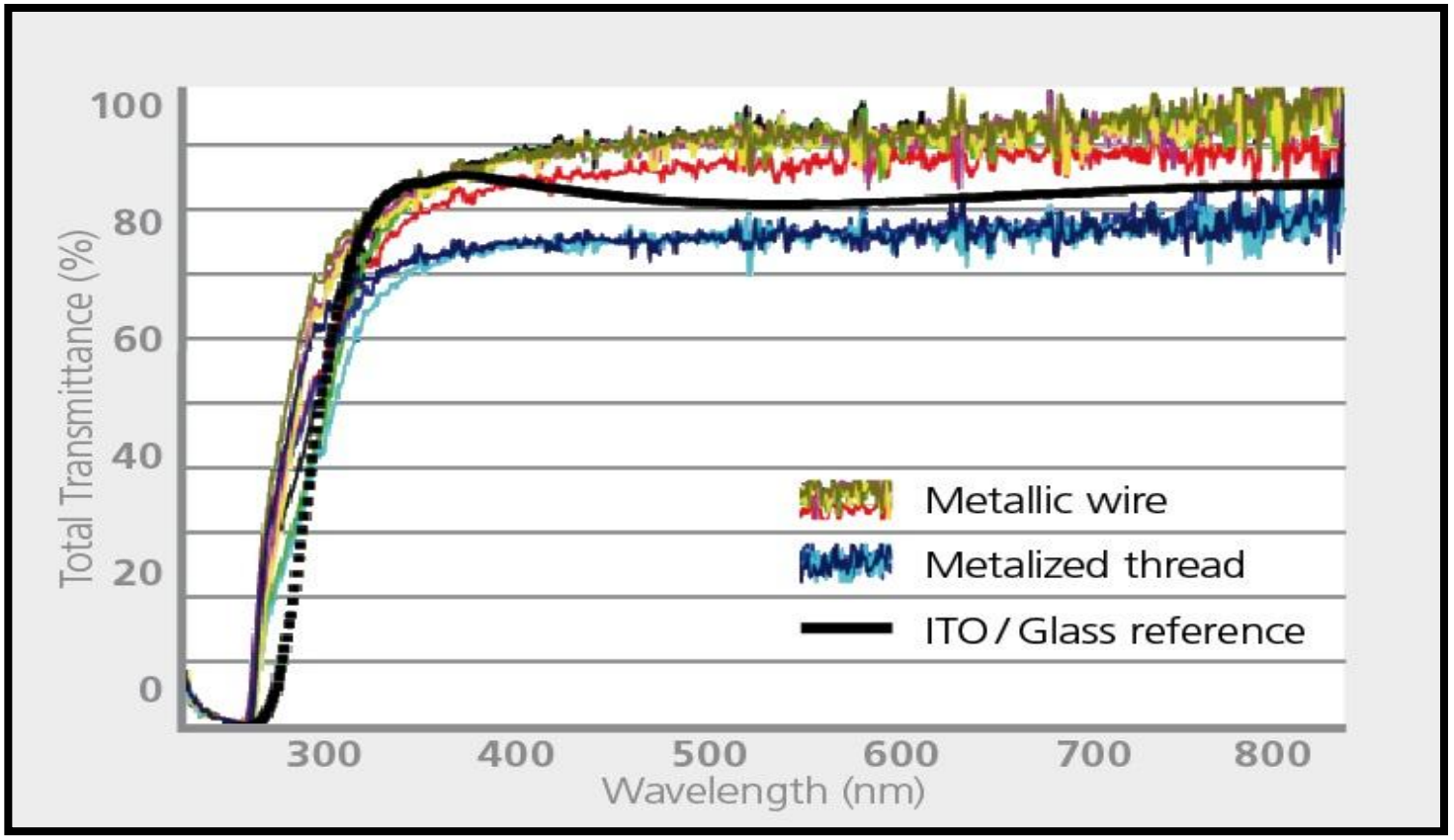
The whole transmittances of some fabric electrodes



Special advantage for hybrid solar cells which work over a broad spectral region (350-1500 nm)

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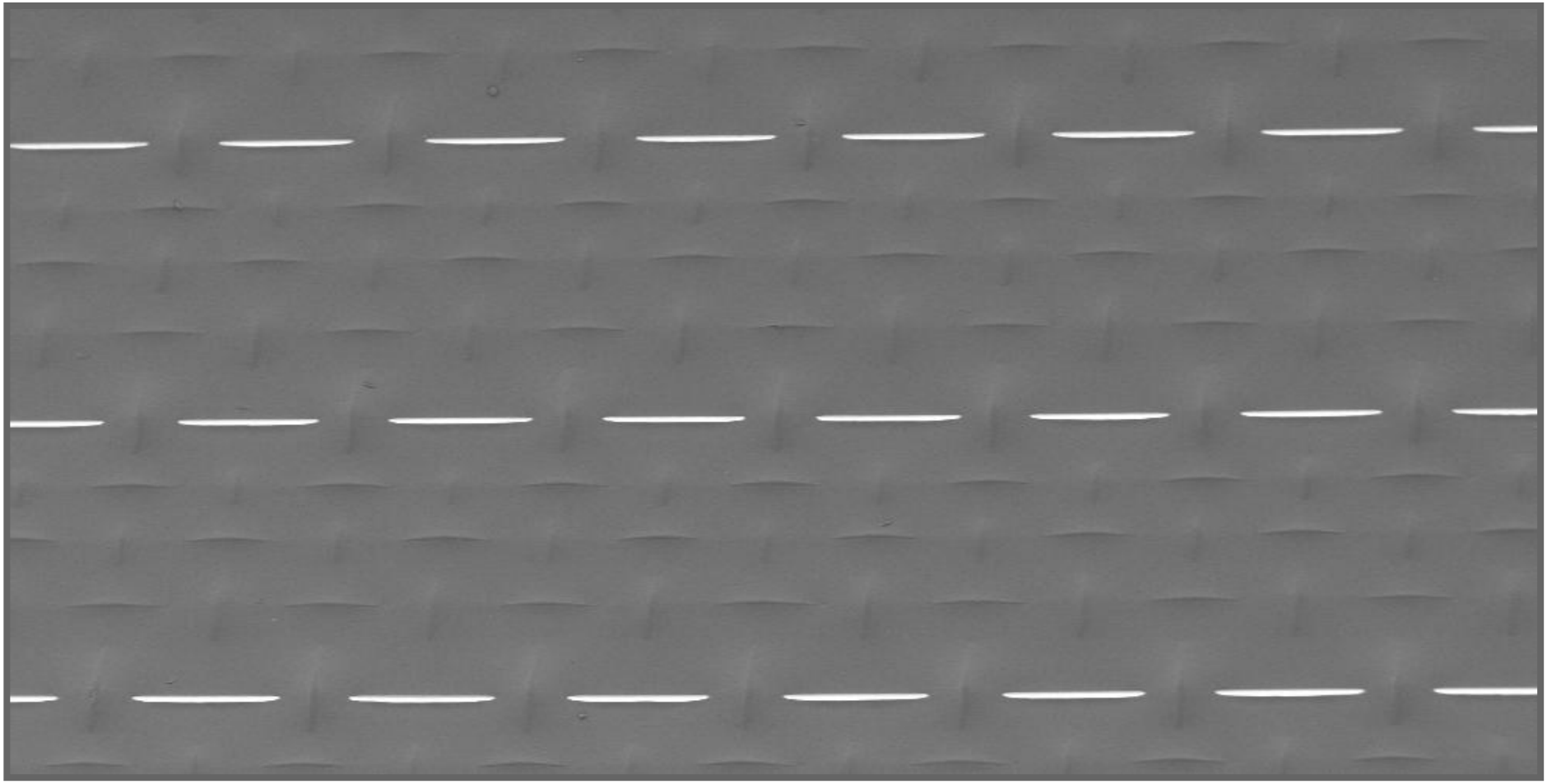
SEM of the coated conductive fabric electrode



Roughness between hills (thread) and valleys (covered holes) is in the range 5-10 µm

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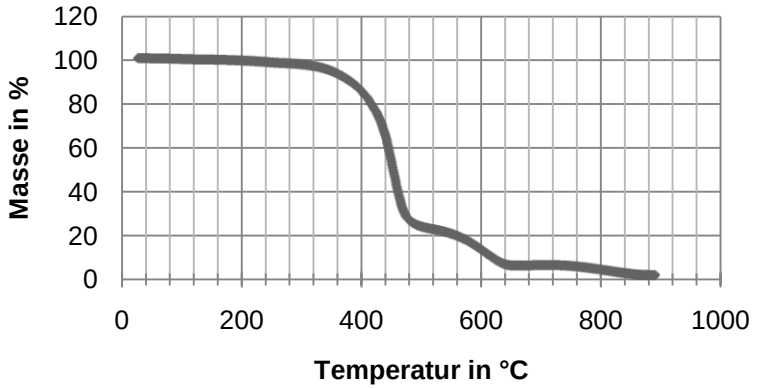
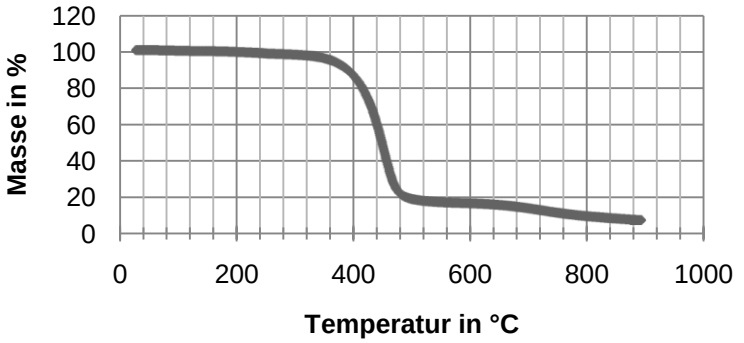
Properties of UV coating polymer

- 280°C temperature stabile
- Highly transparent (86-87%)
- High conductive (1-2 Ohm/sq.)
- “Flexible” (roll2roll production possibility)
- Filling degree of the fabric: ca. ¾ of the fabric thickness
- Electrodes contact OK
- Curing time < 1 min

V 7_2.1 in O_2



V 7_2.1 in He



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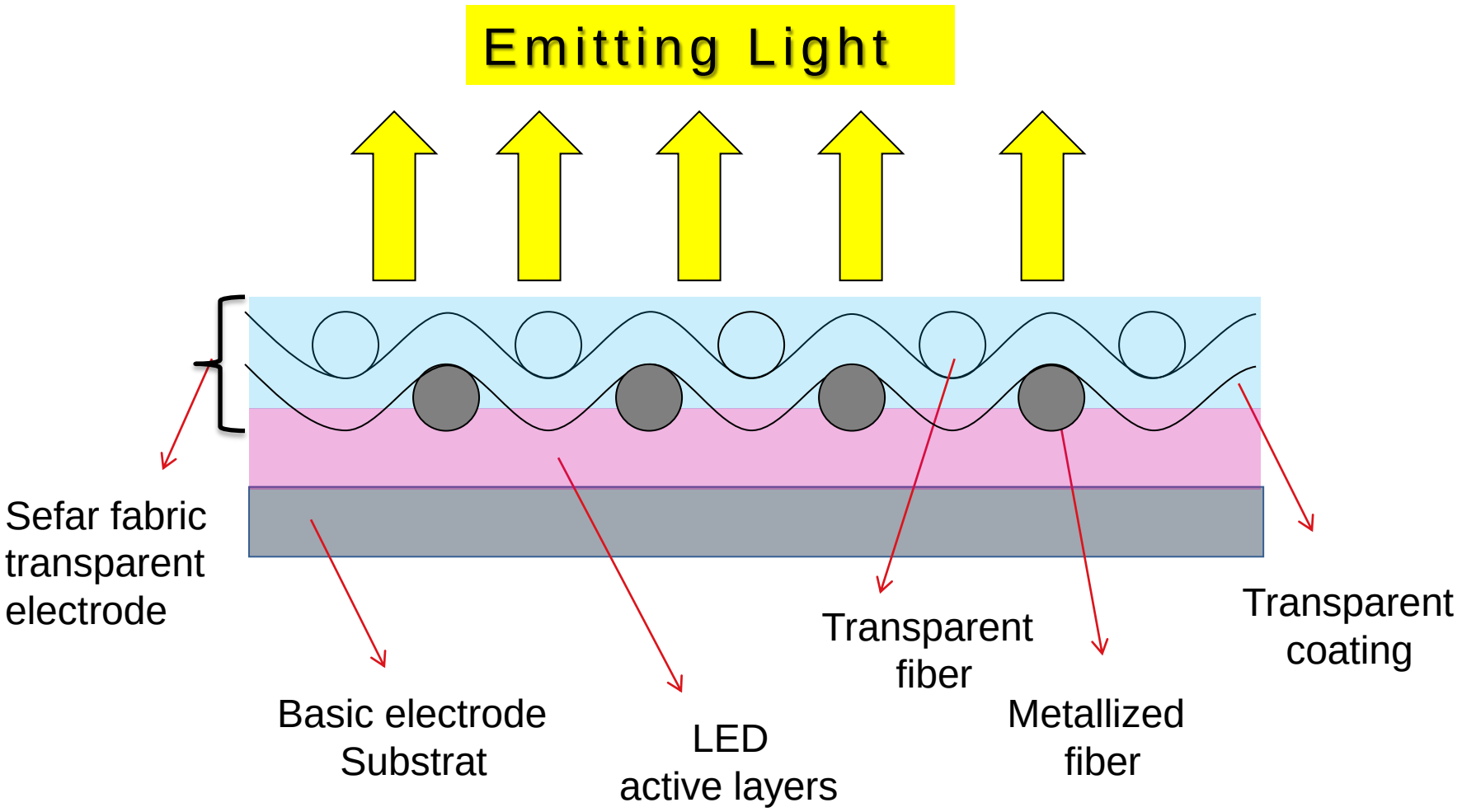

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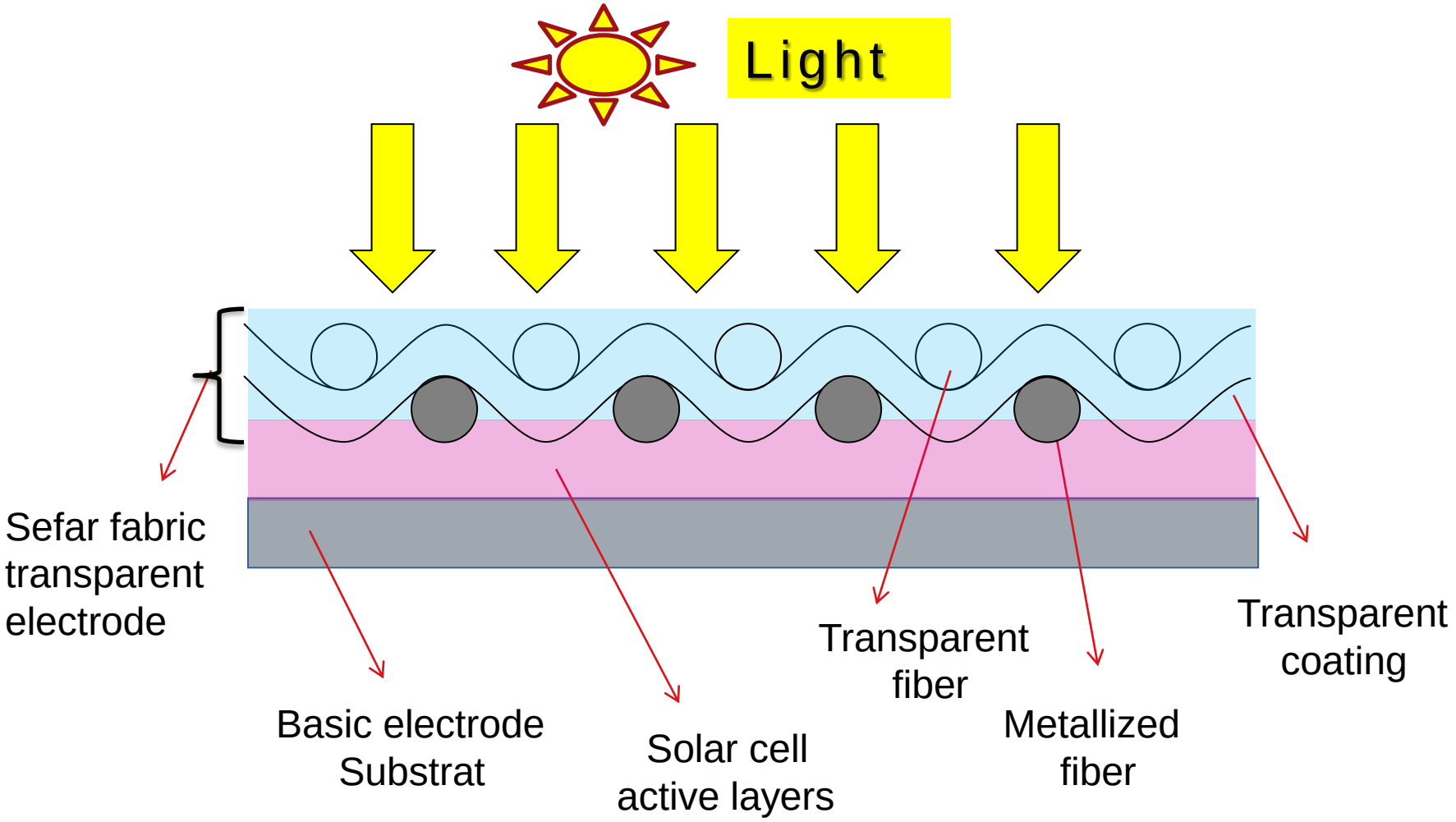

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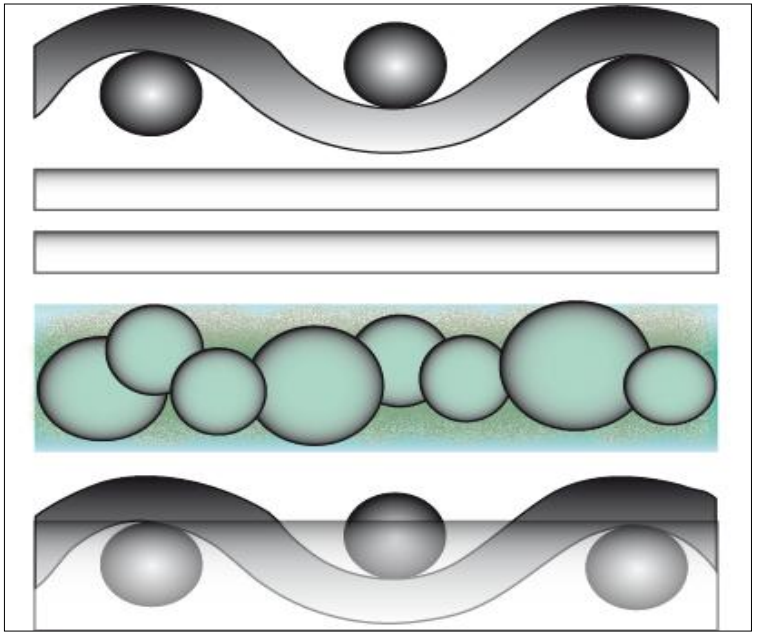
Application in electroluminescent light emitting devices

- **Very fine metalized fabric as an alternative to the ITO transparent electrode**



• Back electrode: Metalized foil or **SEFAR metalized mesh**

• 2 dielectric layers

• EL active layer

• Front electrode: SEFAR metalized mesh **with transparent coating**

Cooperation with Zumtobel Lighting GmbH

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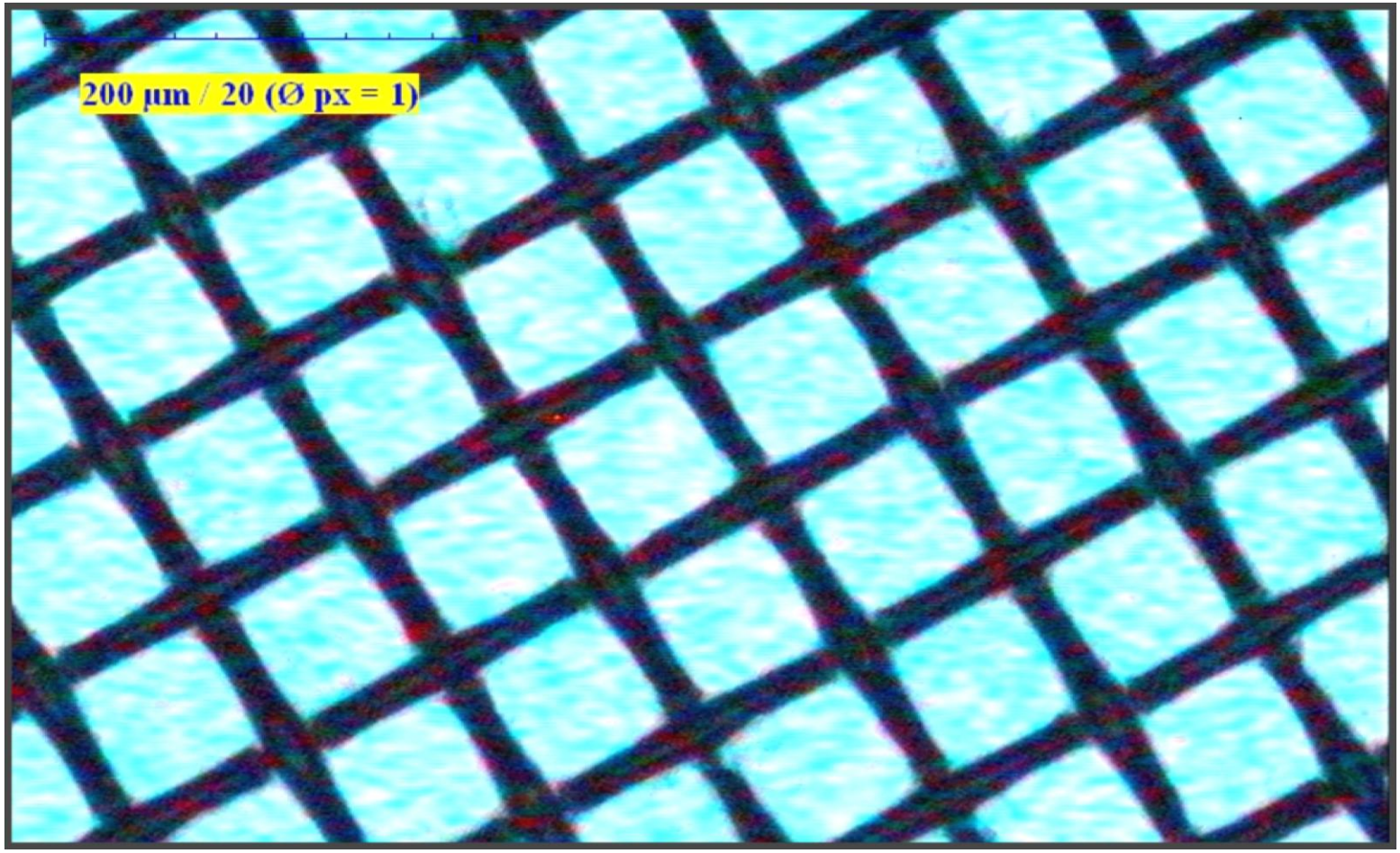
Example of an electroluminescent lamp



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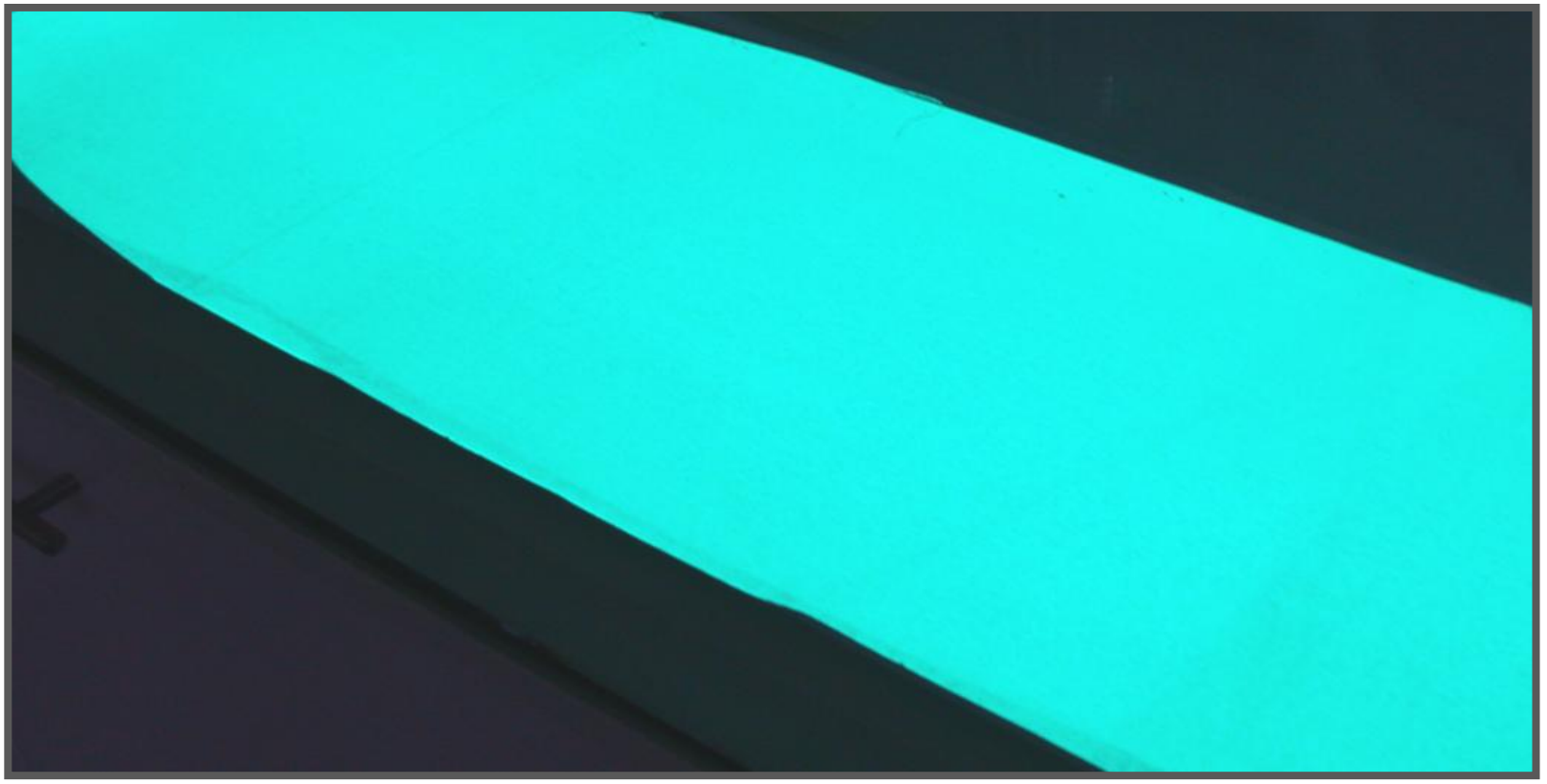

Performance at 100 V and 400-800 Hz: 50-80 Cd/m^2, 2.5 mW/cm^2

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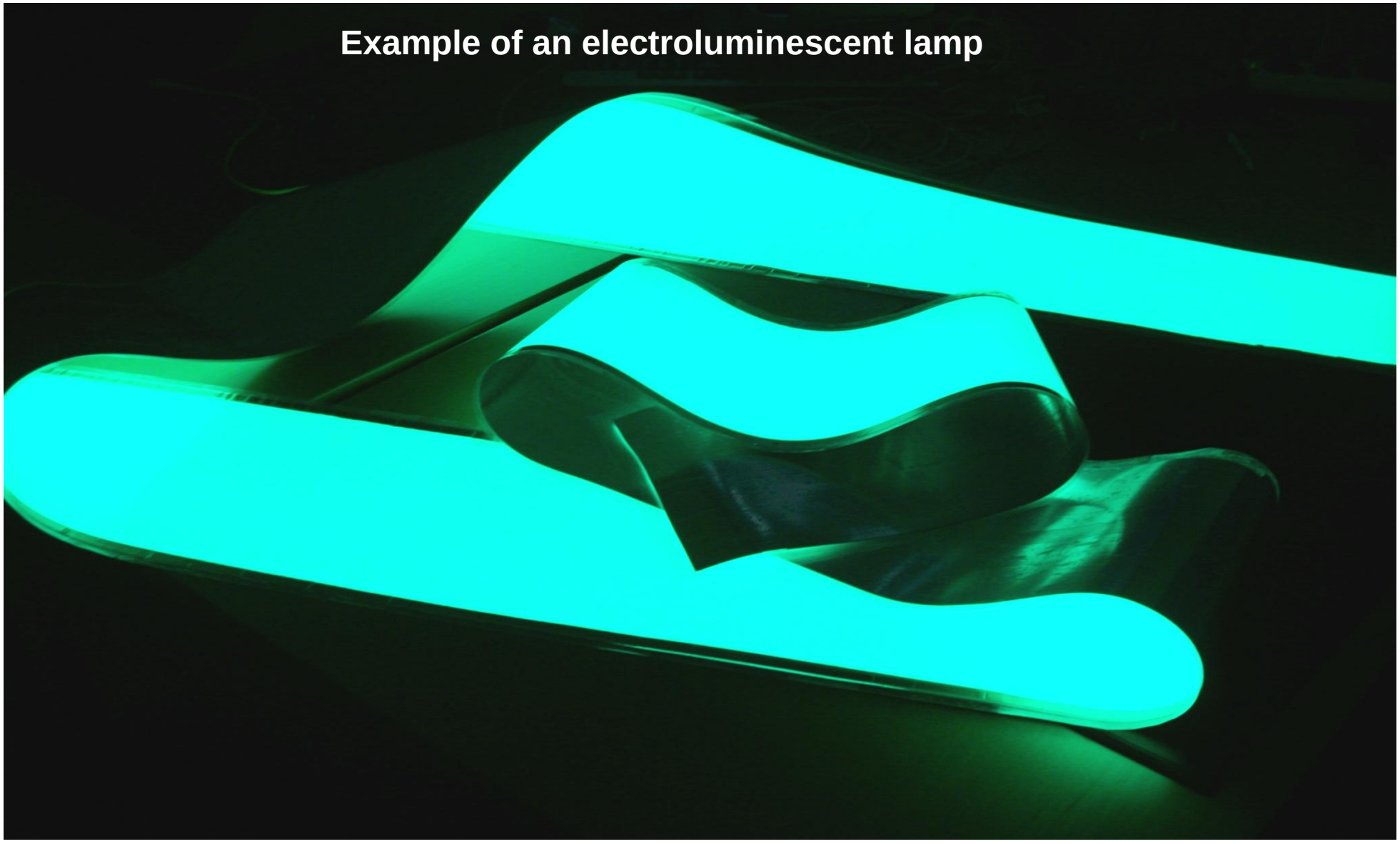

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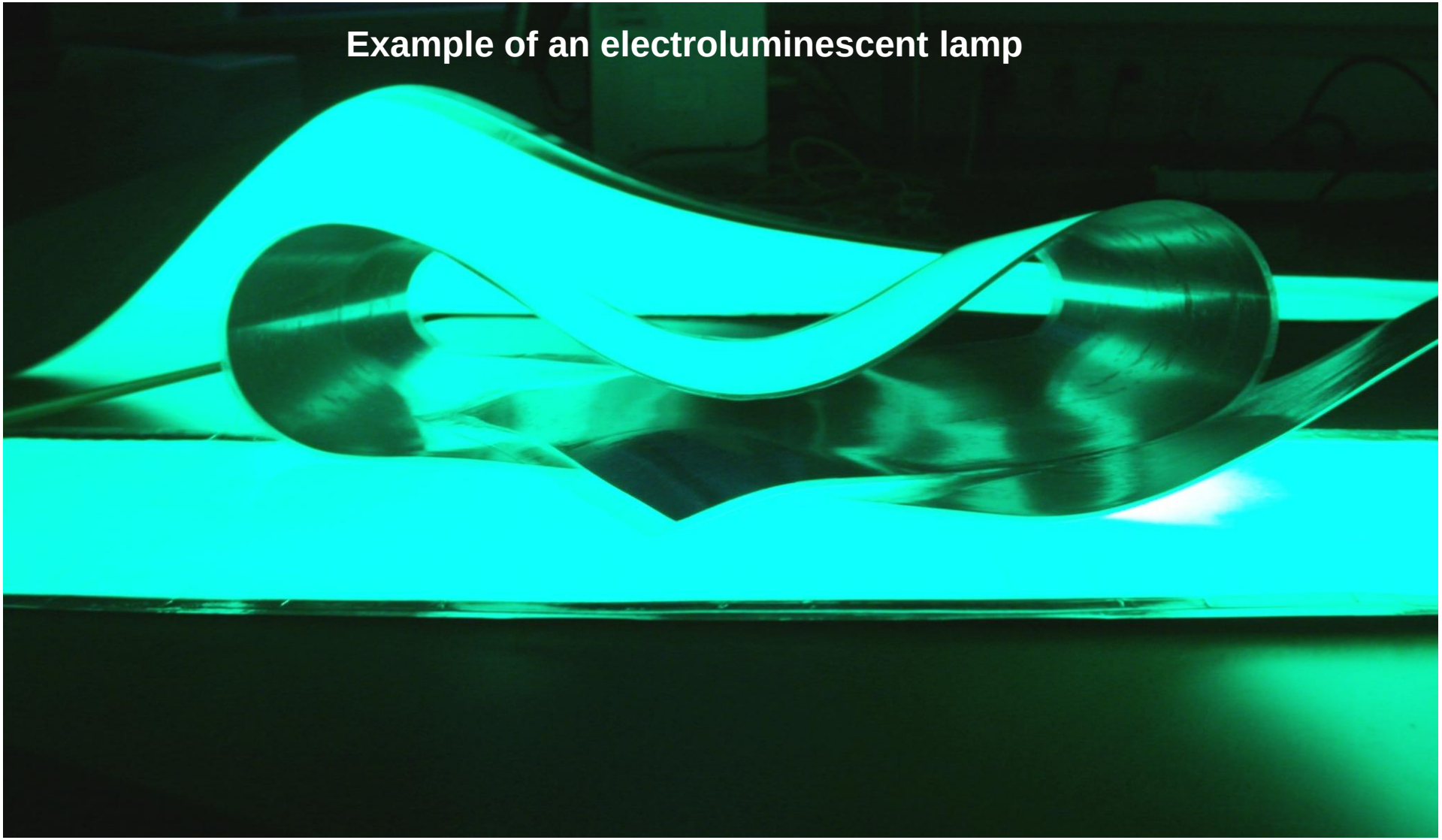

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Fabric based electrodes for electroluminescent light emitting devices

- **Cheaper than ITO coated foil:** about 2 x
- **High conductive: 0.2-1.8 Ω/m² depending on the metal**
  - ➔No need of a bus bar
  - ➔Roll-to-roll process
  - ➔Large surface
  - ➔Higher drive frequencies
  - ➔Possibility of two side light emitting lamp
- **More flexible – no ITO coating needed**
- **Enough transparent : 75% transmission at 560 nm**

Patent pending DE 10 2009 017 787.4

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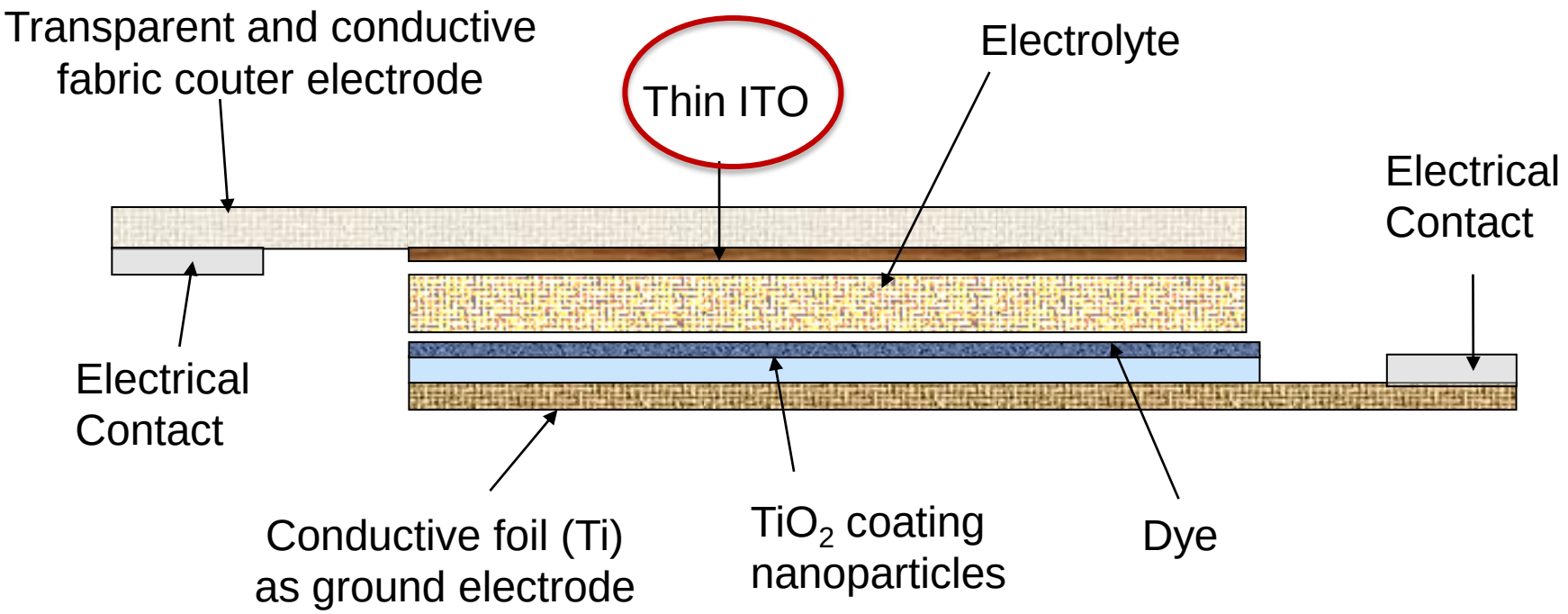
Construction of DSC with Sefar fabrics electrodes



US Patent 2009 293950 (A1)

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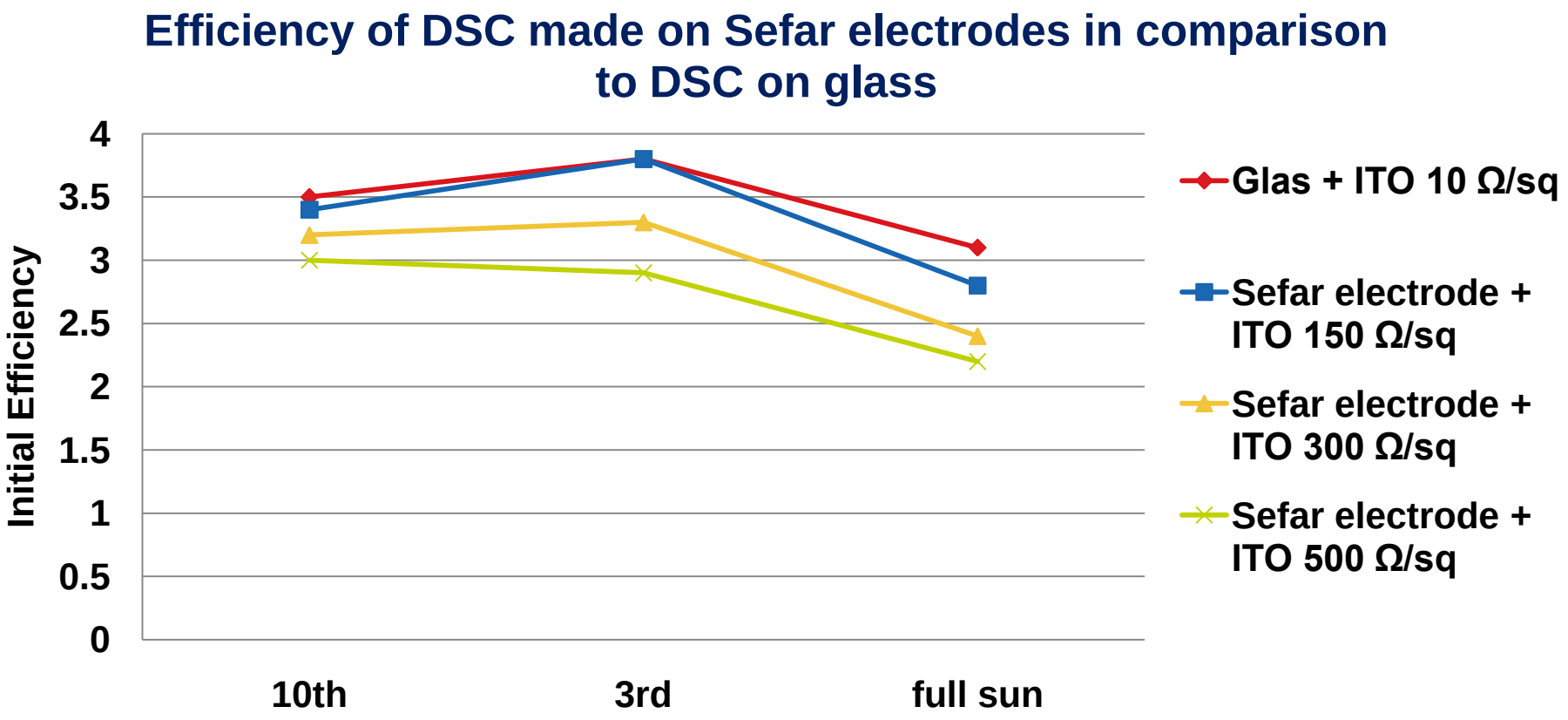

Cooperation with Dyesol Ltd.

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Outlook

- As demonstrated, the fabric based transparent and flexible electrodes can be used in production of:
  - ITO free electroluminescent light emitting devices
  - DSC solar cells (very thin ITO coating still needed)
  - ITO free organic solar cells
- Many new applications can appear where these substrates may be used (light-emitting diodes, touch screens, photodetectors, displays)
- The possibility of roll-to-roll production can strongly decrease the prices of optoelectronic products. They will be cheaper than products on the market which are based on doped metal-oxides

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