

Low-cost, Best Performing Flexible Transparent Conductive Films

with Green Manufacturing Technology

EMI
Shielding

5

Smart
Glass

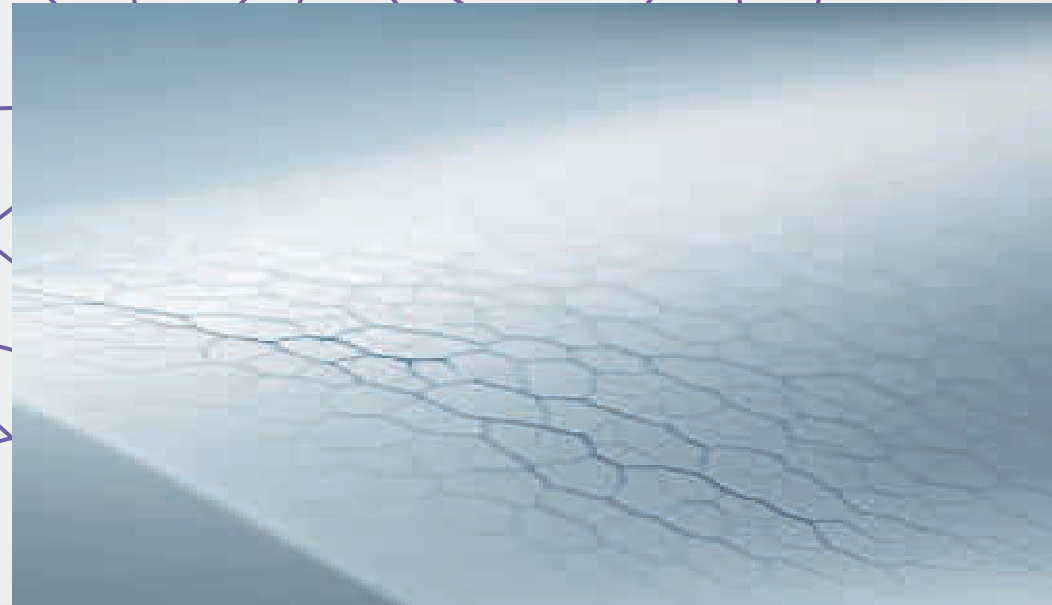
Anti-
ice

Solar

Anti-fog

Touch
Sensors

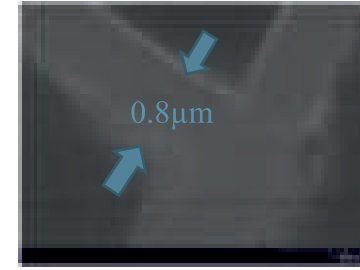
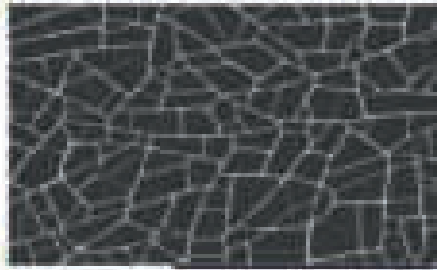
OLED
Displays
&
Lighting



TECHNOLOGY

Large area low-cost R2R fabrication of metal mesh transparent conductive films without lithography

- The best combination of **performance – cost – scale**
- Proprietary inexpensive self-assembled **active template** with controllable and independent geometry: linewidth – pitch – thickness. Active template enables **high-yield** lift-off process and **thicker** metal lines (the record metal mesh conductivity)
- **Low cost & easy scalability**: no optical or nanoimprint lithography
- Wide range of conductive materials: Cu, Ag, Au, Pd, Mo, Ni, Fe, W, Sn, Ti, etc.
- R2R manufacturing: readily available material deposition equipment
- **Green technology**: non-hazardous non-toxic template material and water-based lift-off process. Utilization of the residual metal through fabrication and sale of conductive pastes
- IP Portfolio: one issued and one pending patents

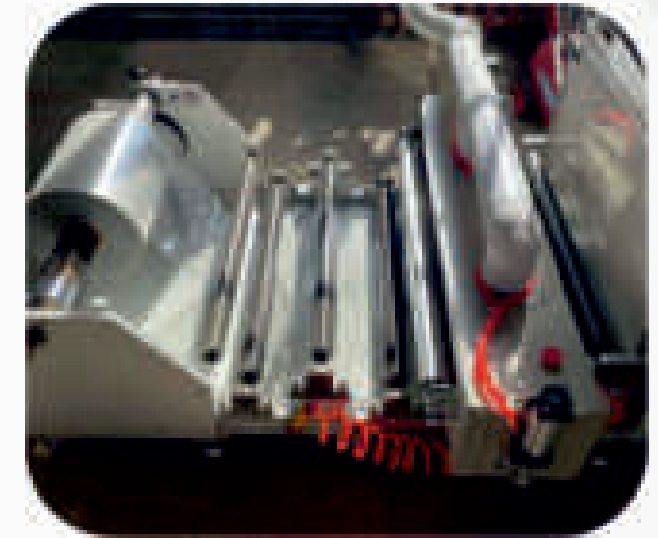


PRODUCTION CAPABILITIES (2024)



ROLL-TO-ROLL TEMPLATE PRODUCTION MODULE:

- Width: 0.6 m
- Max roll length: 1000 m
- Average volume: 80 rolls/month
- Cost: <\$25/m² (further major cost reduction to follow)



Precursor
Preparation

Template
deposition

Metal deposition

Template removal
(lift-off)

Transparent
Conductive
Film

Conductive Paste
from 2D-Metal Powder



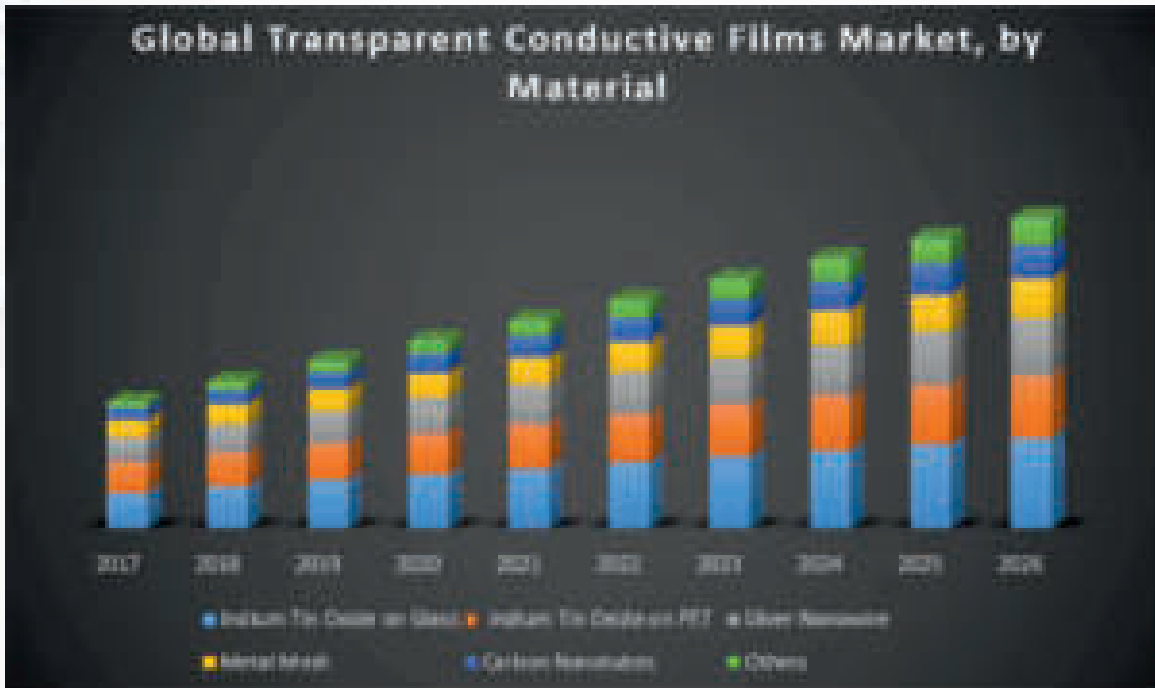
| COMPANY | TCF TYPE | FABRICATION METHOD | LINEWIDTH μm | MESH VISIBILITY | SCALE (WIDTH), m | COST \$/m ² | RESISTIVITY $\Omega/$ | TRANSMISSION % | FLEXIBILITY |
|---|--------------------|----------------------------------|-------------------------|-----------------|------------------|------------------------|-----------------------|----------------|-------------|
| CB TEC (ES) | Metal mesh | Self-forming cracks in template | <2 | No | 0.6→1.2 | <25 | 0.9 | 35 | Good |
| METAMATERIALS/ROLITH (US) | | Photolithography (photoresist) | Sub- 1 | No | 0.3 | 250→ 100 | 1 | 70 | Good |
| FUJIFILM (JP) | | Photolithography (silver halide) | 5 | Yes | 0.5 | 20 | 0.1 | 30 | Good |
| CHASM (US) MICROCONTINUUM (US) ASAHI KASEI (JP) | | Nanoimprint Lithography | Sub- 1 | No | 0.25 | 100 | 1 | 70 | Good |
| XTPL (PL) KONICA (JP) | | Inkjet printing | 10 | Yes | N/A | N/A | N/A | N/A | Good |
| GUNZE (JP) | | Screen Printing | 20 | Yes | N/A | N/A | N/A | N/A | Good |
| KOMURA-TECH (JP) | | Gravure Offset printing | 5 | Yes | N/A | N/A | N/A | N/A | Good |
| C3NANO (US) CAMBRIOS (US) | | Coating | Silver Nanowires | - | - | 1.3- 1.6 | 30- 100 | 10 | 30 |
| CANATU (FI) | Carbon Nanotubes | | - | - | N/A | N/A | 35 | 30 | Good |
| HERAEUS (EU) AGFA (EU) | Organic Conductors | | - | - | N/A | N/A | 30 | 35 | Good |
| TDK (JP) | Ag alloy | | - | - | N/A | N/A | 1 | 32 | Bad |
| NITTO (JP) | ITO | | - | - | 2.5 | 13- 150 | 20 - 350 | >75 | Bad |

MARKET



The global transparent conductive films market size was \$6.72 billion in 2023 and is projected to reach \$16 billion by 2032 at a CAGR of 10.10%.

Expert Market Research. Global Transparent Conductive Films Market Report and Forecast 2024-2032



Metal Mesh technologies market (Serviceable Available Market, SAM) will reach approximately 13% of Transparent Conductor Films market share by 2032, with the TAM equal to \$2.08 B.*

CB TEC products market (Serviceable Obtainable Market, SOM) is projected to reach at least 10% of SAM by 2032 with >\$208 M revenue.**

* Revenue will be further increased by expanding into non-flexible products (transparent metal mesh conductors on thick glass and semiconductor wafers, etc.)

** Revenue will be also complemented by the sales of conductive pastes from utilized 2D-metal flakes

Applications

Transparent heaters

- Sensors (cameras, LIDARs), mirrors, windows, headlights, drones for anti-ice, anti-fog
- Wearables: goggles, visors, glasses

Transparent antennas & reflectors

- Radars and antennas for transportation and mobile electronics
- 5G communication

Transparent electrodes

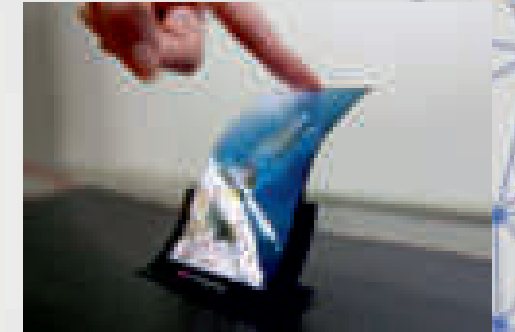
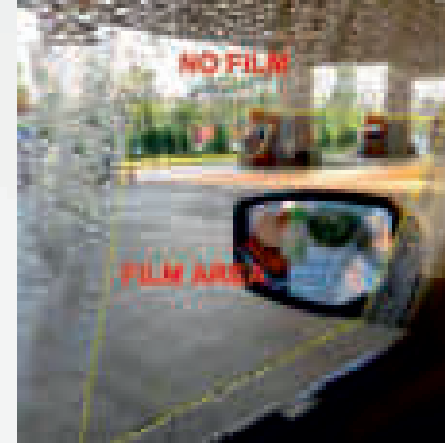
- Displays: touch sensors,
- Lighting: LEDs, OLEDs, μ LEDs
- Smart glass: electrochromic, SPD

Transparent EMI shielding

- Displays, sensors, circuits
- Mobile electronics
- Medical & industrial instrumentation
- Microwave appliances
- Data Security

Transparent Flexible Photovoltaics

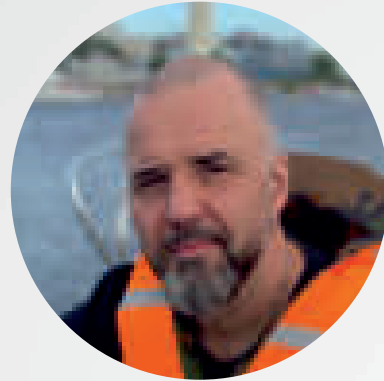
- Flexible organic solar cells
- Perovskite PV
- BIPV





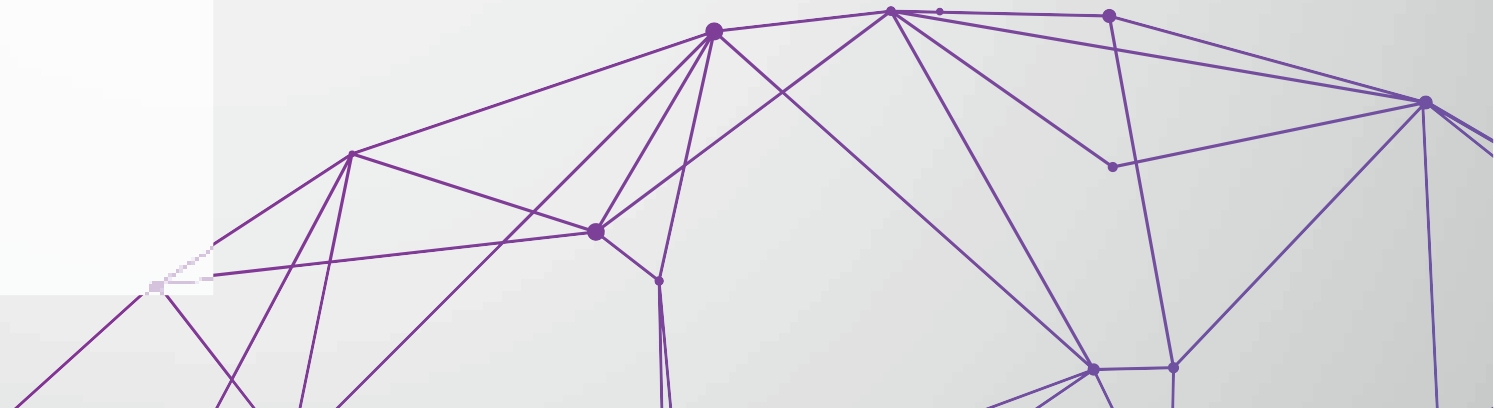
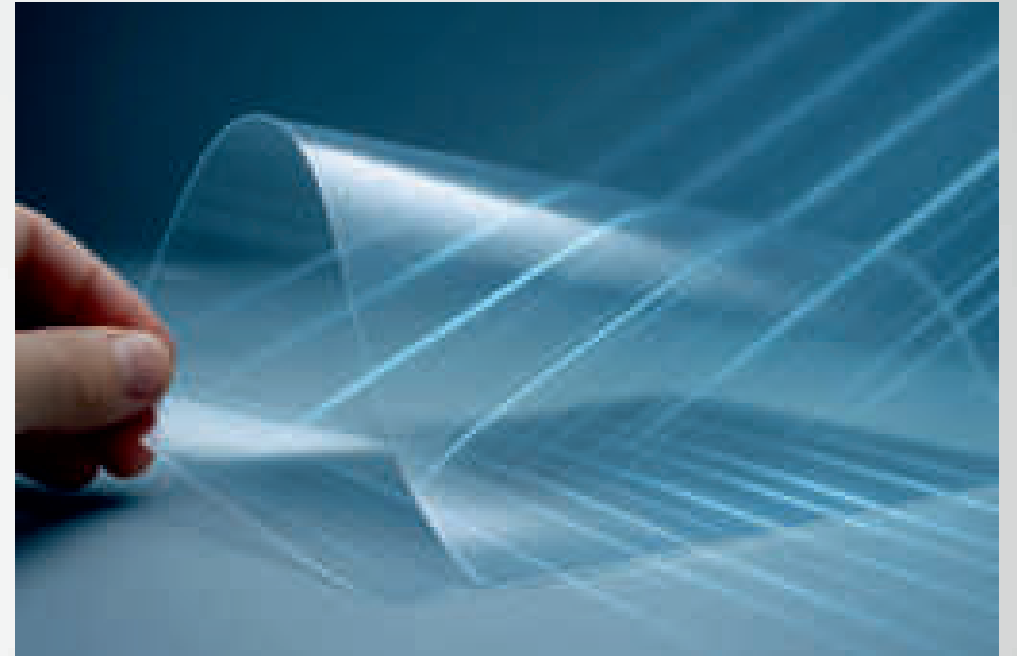
Alex Levin, CEO EU

Entrepreneur. Strategic leader.
Driving innovation and Growth.



**Yuri Kudrin,
VP R2R Manufacturing**

M.Sc. Industrial Printing Technologies & Electronics Manufacturing, Saint Petersburg University, Russia; Chief Technologist at Neoprint, CCL-Kontur, SATO-OKI, iGlass Technology and Centrinform. 2 publications, 1 patent. Security Document World Award (SDW, London)



High RF-signal Reflection Efficiency:

CB TEC films fabricated or laminated on windows, walls and other objects, provide up to 99.7% reflection efficiency of 5G signals and keep high >>80% windows transmission. This allows to minimize/eliminate dead reception zones inside and outside of the buildings.

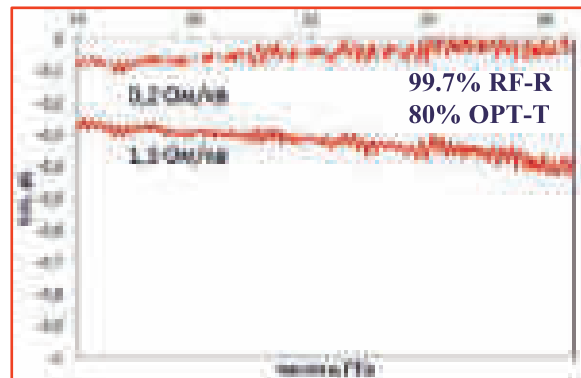
Mesh Invisibility & High Transmission:

Ability to fabricate metal grid with **high resolution** (down to 2 μm) assures **invisibility** of 5G reflector to a naked eye, even in close distance view; ability to fabricate **tall metal lines** for high conductivity without the need to increase line density allows to keep **transmission** of the product high.

Large scale & Low Cost:

CB TEC technology is easily **scalable** to large product size: currently operating on 0.6 m R2R production line.

| | Reflection | Transmission | Mesh visibility | Flexibility | Scale | Cost |
|-------------|------------|--------------|-----------------|-------------|-------|------|
| ITO | Mid | Mid | - | No | Large | Low |
| AgNW | Mid | Mid | No | Yes | Large | Mid |
| Metal wires | Low | Mid | Yes | Yes | Large | Low |
| Metal mesh | Mid | High | No | Yes | Mid | High |
| CB TEC | High | High | No | Yes | Large | Low |



High Shielding Efficiency:

Complete electromagnetic shielding (**up to 70 dB**) has been achieved over wide range of radio frequencies with flat frequency response; single or both sides conductive material on polymer and glass films or plates.

Mesh Invisibility & High Transmission:

Ability to fabricate metal grid with **high resolution** (down to 2µm) assures **invisibility** of EMI shield to a naked eye, even in close distance view; ability to fabricate **tall metal lines** for high conductivity without the need to increase line density allows to keep **transmission** of the product high.

Large scale & Low Cost:

CB TEC technology is easily **scalable** to large product size: currently operating on 0,6 m R2R production line.

Flexibility & Integration Options:

CB TEC transparent conductors are available on **polymer films laminated**

CB TEC transparent conductive films are highly resistant to **flexing and folding**

| | Efficiency | Transmission | Mesh visibility | Flexibility | Scale | Cost |
|-------------|------------|--------------|-----------------|-------------|-------|------|
| ITO | Mid | Mid | - | No | Large | Low |
| AgNW | Mid | Mid | No | Yes | Large | Mid |
| Metal wires | Low | Mid | Yes | Yes | Large | Low |
| Metal mesh | Mid | High | No | Yes | Mid | High |
| CB TEC | High | High | No | Yes | Large | Low |



Large Touch Screen Size:

Extremely low sheet resistance of CB TEC films (down to $0.9 \Omega/\square$) and easy scalability of proprietary Roll-to-Roll manufacturing process to Roll width up to 1.2 m wide will enable large format (>40" diagonal) high performance touch screens, which are impossible to fabricate using competitive TCF technologies.

Mesh Invisibility & High Transmission:

Ability to fabricate metal mesh with **high resolution** (down to $2 \mu\text{m}$) assures **invisibility** of touch sensor electrodes to a naked eye, even in close distance view; ability to fabricate **tall metal lines** for high conductivity without the need to increase line density allows to keep **transmission** of the product high.

Low Cost:

CB TEC technology is easily **scalable** to large product size: currently operating on 0.6 m R2R production line.

Flexible & Foldable Displays:

CB TEC transparent conductors are available on **polymer films**

CB TEC transparent conductive films are highly resistant to **flexing and folding**. High stability of CB TEC films to bending and folding makes fabrication of foldable and flexible touch screens possible.

| | Conductivity | Transmission | Mesh visibility | Flexibility | Scale | Cost |
|-------------|--------------|--------------|-----------------|-------------|-------|------|
| ITO | Low | Mid | - | No | Mid | Low |
| AgNW | Low | Mid | No | Yes | Mid | Mid |
| Metal wires | High | Mid | Yes | Yes | - | Low |
| Metal mesh | Mid | High | No | Yes | Mid | High |
| CB TEC | High | High | No | Yes | Large | Low |



Low Voltage & High Speed:

$P=V^2/R$ means that the amount of heat (P) of the heater is inversely proportional to the resistance (R) under a constant voltage power supply. Therefore, if the conductive material used for the heater has a **resistance as low as possible**, the **heating capacity** will be higher. **As the result**, the system can use **low voltage power supply** (important for automotive, mobile electronics, wearables) and heating process could be **faster**.

Mesh Invisibility & High Transmission:

Ability to fabricate metal grid with **high resolution** (down to 2 μm) assures **invisibility** of CB TEC transparent heater to a naked eye, even in close distance view; ability to fabricate **tall metal lines** for high conductivity without the need to increase line density allows to keep **transmission** of the product high.

Large scale & Low Cost:

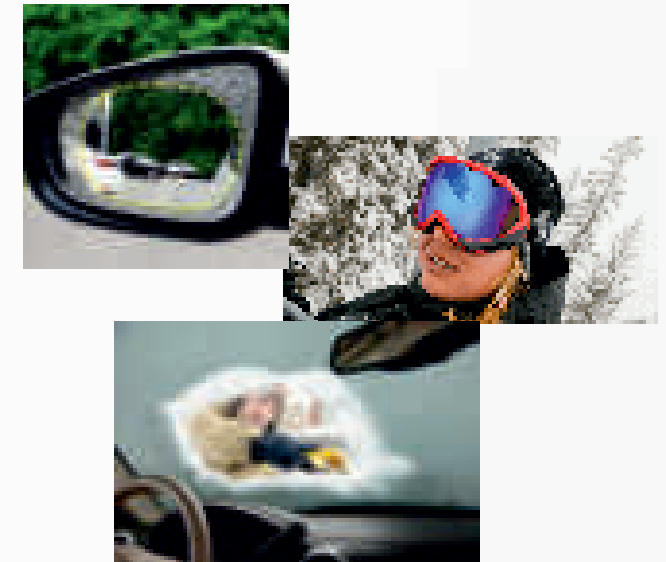
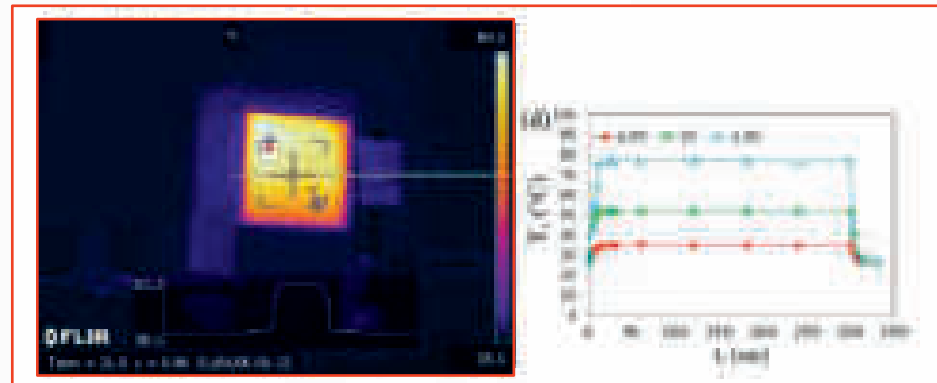
CB TEC technology is easily **scalable** to large product size: currently operating on 0.6 m R2R production line.

Flexibility & Integration Options:

CB TEC transparent conductors are available on **polymer films**

CB TEC transparent conductive films are highly resistant to **flexing and folding**

| | Voltage | Heating Speed | Transmission | Mesh visibility | Flexibility | Scale | Cost |
|--------------------------|---------|---------------|--------------|-----------------|-------------|-------|------|
| ITO | High | Low | Mid | - | No | Large | Low |
| AgNW | High | Low | Mid | No | Yes | Large | Mid |
| Metal wires | Low | Fast | Mid | Yes | Yes | Large | Low |
| Metal mesh (competition) | Mid | Mid | High | No | Yes | Mid | High |
| CB TEC | Low | Fast | High | No | Yes | Large | Low |





CB TEC

Thank You for Your Time !