

Prototyping Transparent and Flexible Electrochromic Displays

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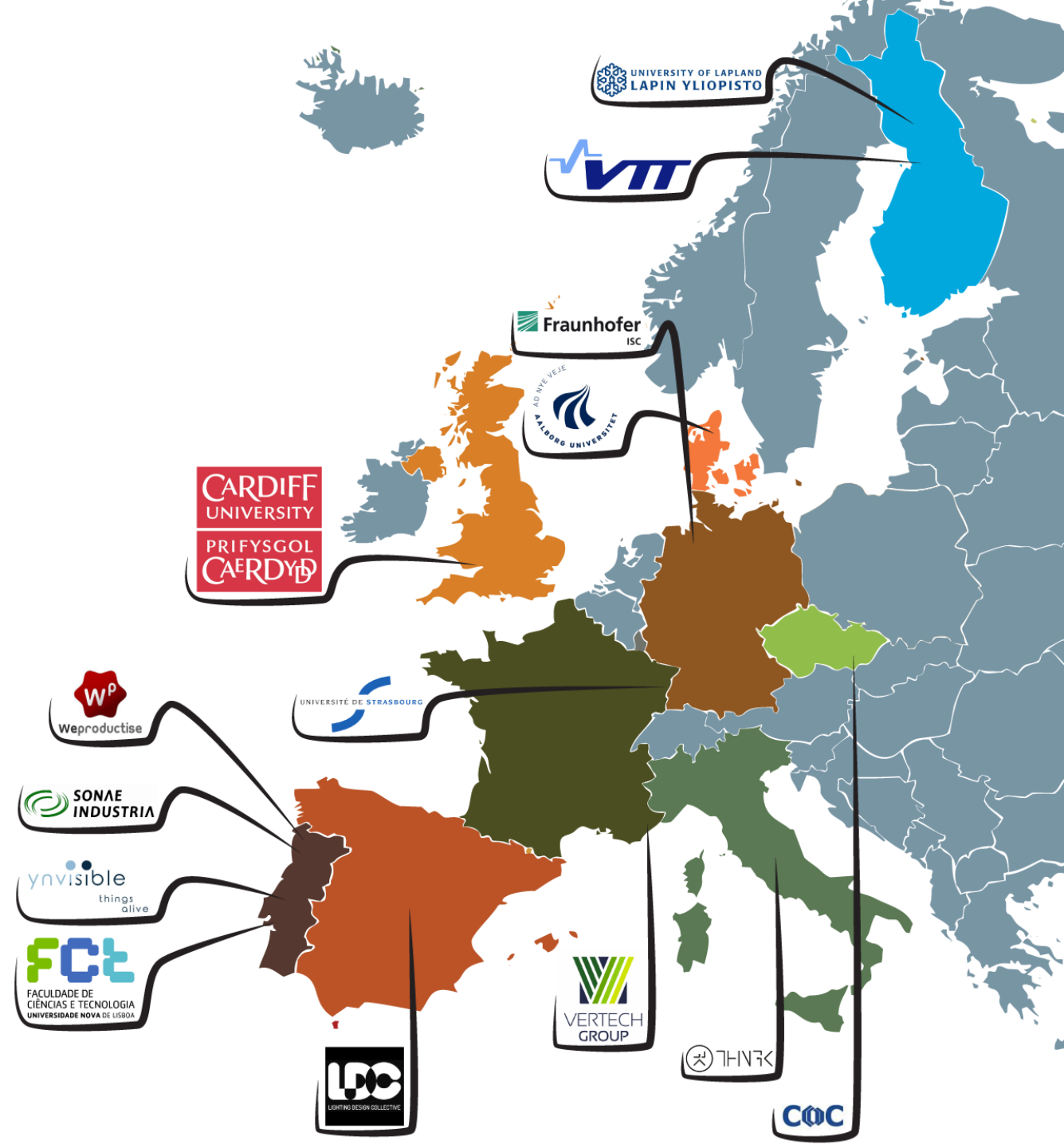


This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 760973.



Overview

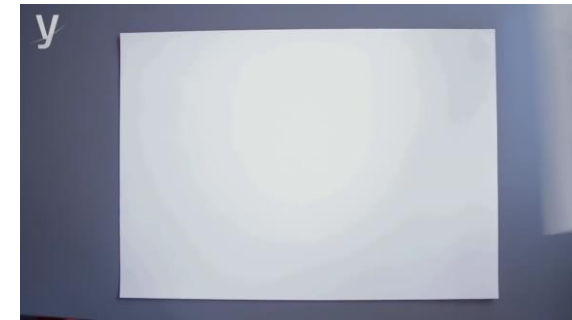
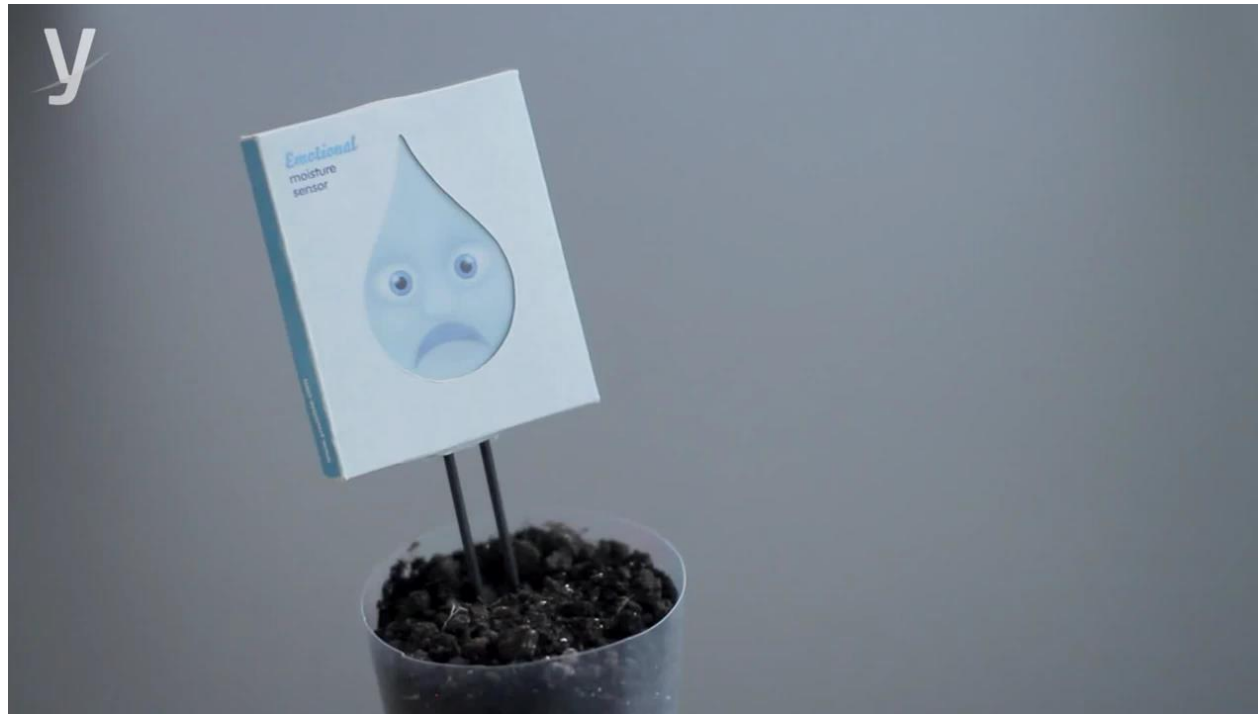
- EU funded Horizon2020 project
- 4 year project (January 2018 – December 2021)
- 7M€ total budget
- 14 partner organisations from 9 countries



The Goal:

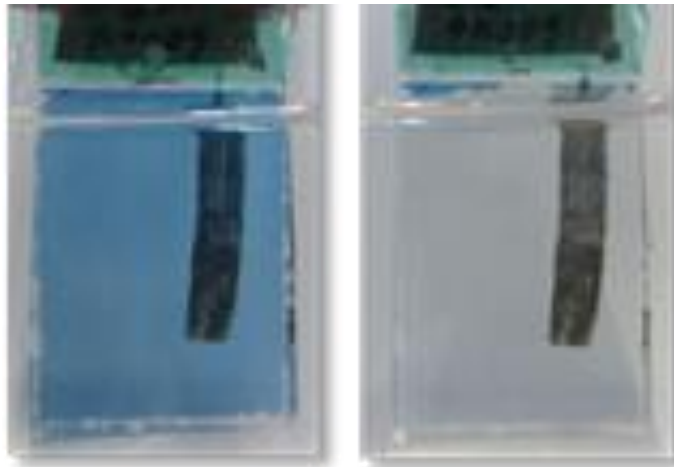


Electrochromic?

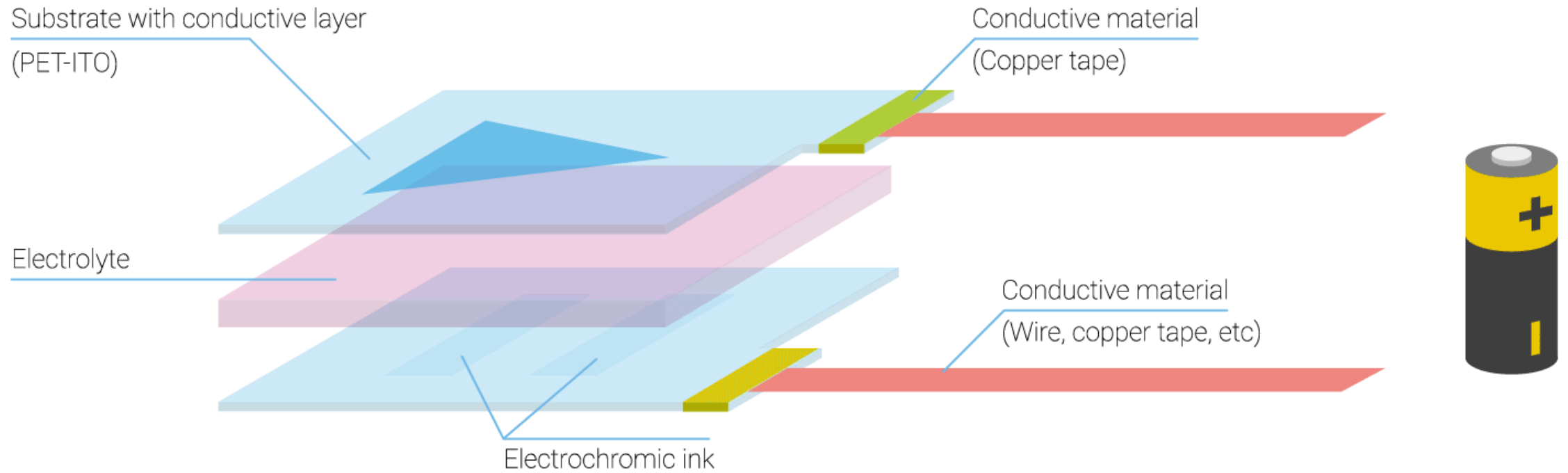


Basically it is Rust...

- Ink that can be oxidized and reduced through electricity
- BUT:
 - In one of the states it is transparent!
 - Reversible Process!



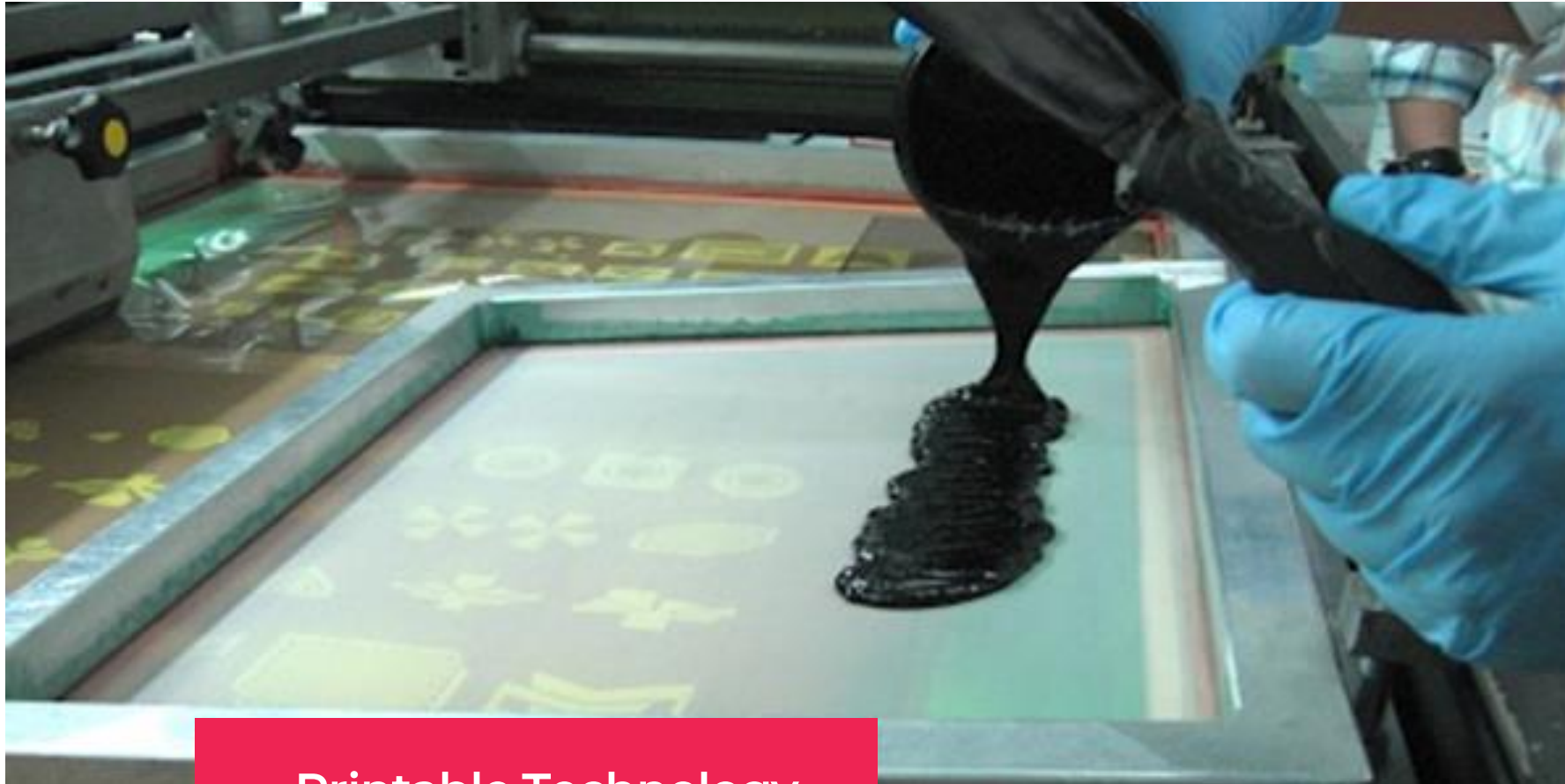
How does it work?



Smart Windows...



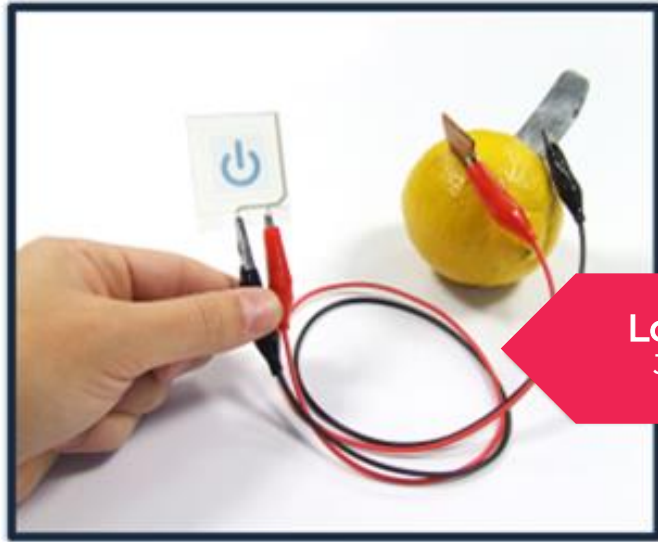
Production



Printable Technology

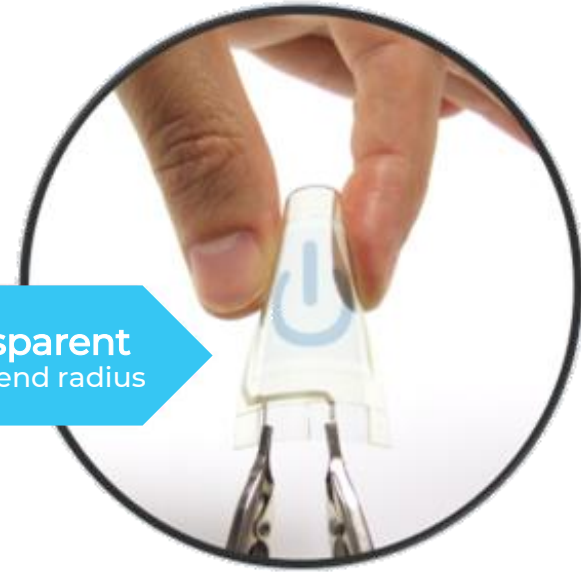


Technology Strong Points



Low Power - Low Voltage
Just a few mW – < 1V up to 3V

Thin – Flexible – Transparent
< 230mm thickness – 7mm bend radius



Free-Form Factor



Technology Strong Points

Operable over wide Temperature range



Remains functioning with physical damage



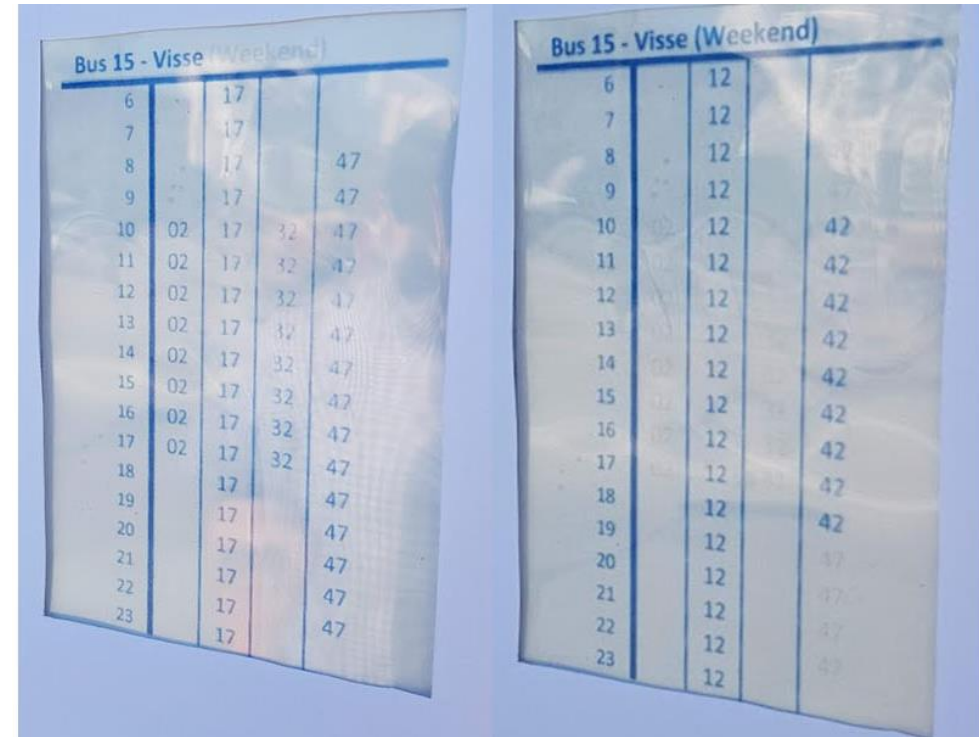
Application Cases

- Switchable Logo's and Sign's
 - Simple switch of the two sides
 - Exploit possibility of transparency and flexibility
 - Context adaptive



Application Cases

- Switchable Logo's and Sign's
 - Simple switch of the two sides
 - Exploit possibility of transparency and flexibility
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The image shows two bus stop signs for 'Bus 15 - Visse (Weekend)'. The signs are made of a transparent material that allows the background to be visible through the numbers. The left sign shows a list of numbers from 6 to 23, with some numbers (17, 32, 47) appearing in different colors (red, blue, green) to indicate different bus routes or stops. The right sign shows the same list of numbers, but with different colors (blue, green, yellow) used for the same numbers, demonstrating the flexibility of the design.

| Bus 15 - Visse (Weekend) | | | |
|--------------------------|----|----|-------|
| 6 | | 17 | |
| 7 | | 17 | |
| 8 | | 17 | 47 |
| 9 | | 17 | 47 |
| 10 | 02 | 17 | 32 47 |
| 11 | 02 | 17 | 32 47 |
| 12 | 02 | 17 | 32 47 |
| 13 | 02 | 17 | 32 47 |
| 14 | 02 | 17 | 32 47 |
| 15 | 02 | 17 | 32 47 |
| 16 | 02 | 17 | 32 47 |
| 17 | 02 | 17 | 32 47 |
| 18 | | 17 | 32 47 |
| 19 | | 17 | 47 |
| 20 | | 17 | 47 |
| 21 | | 17 | 47 |
| 22 | | 17 | 47 |
| 23 | | 17 | 47 |

| Bus 15 - Visse (Weekend) | | | |
|--------------------------|----|----|----|
| 6 | | 12 | |
| 7 | | 12 | |
| 8 | | 12 | |
| 9 | | 12 | |
| 10 | 02 | 12 | 42 |
| 11 | | 12 | 42 |
| 12 | | 12 | 42 |
| 13 | | 12 | 42 |
| 14 | 02 | 12 | 42 |
| 15 | 02 | 12 | 42 |
| 16 | 02 | 12 | 42 |
| 17 | 02 | 12 | 42 |
| 18 | | 12 | 42 |
| 19 | | 12 | 42 |
| 20 | | 12 | 47 |
| 21 | | 12 | 47 |
| 22 | | 12 | 47 |
| 23 | | 12 | 47 |



Application Cases

- Interactive Paper Overlays
 - Exploit cheap printed graphics and make them interactive
- Low-Energy Consumption



Interactive Art

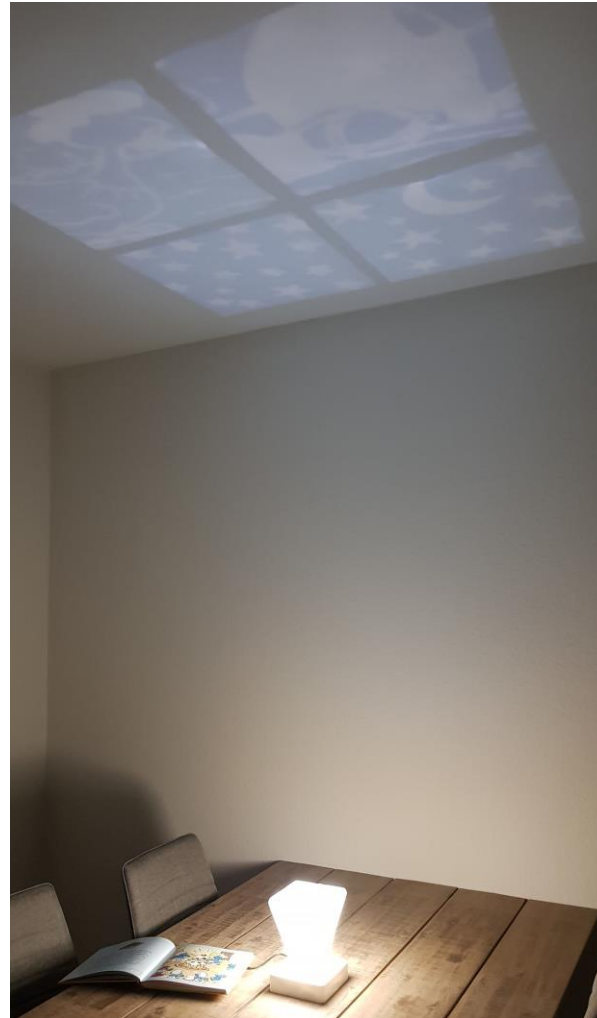


Interactive GameCard

Smarter Windows



ShadowLamp



Banksy



Shoes



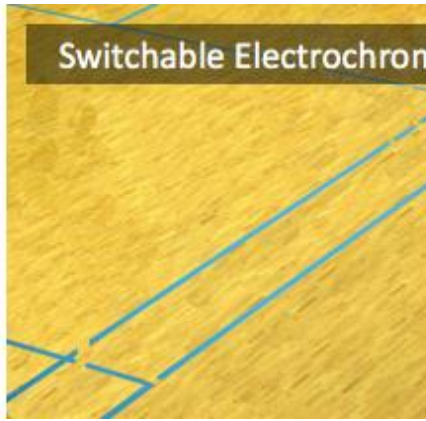
What's next?



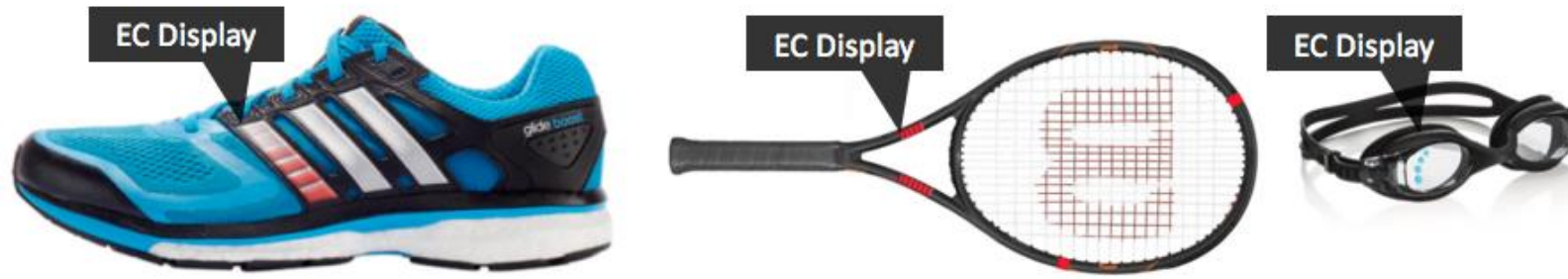
Vision – Smart Furniture



Vision – Smart Buildings



Vision – Active Life



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Please if you post something about today: #decochrom





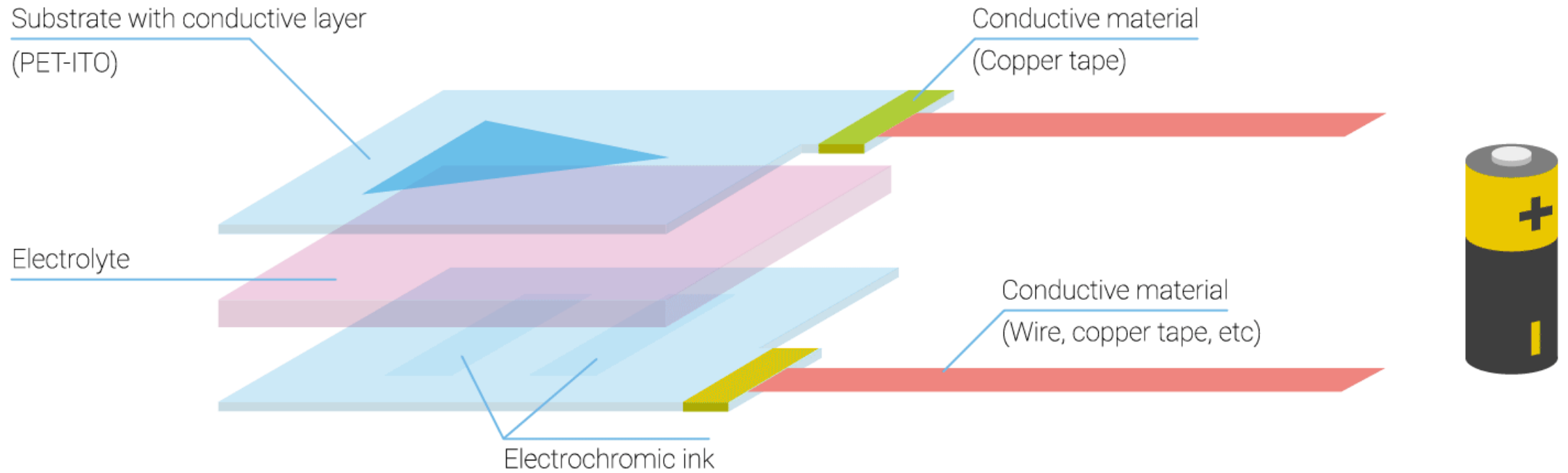
Construction of Electrochromic Displays



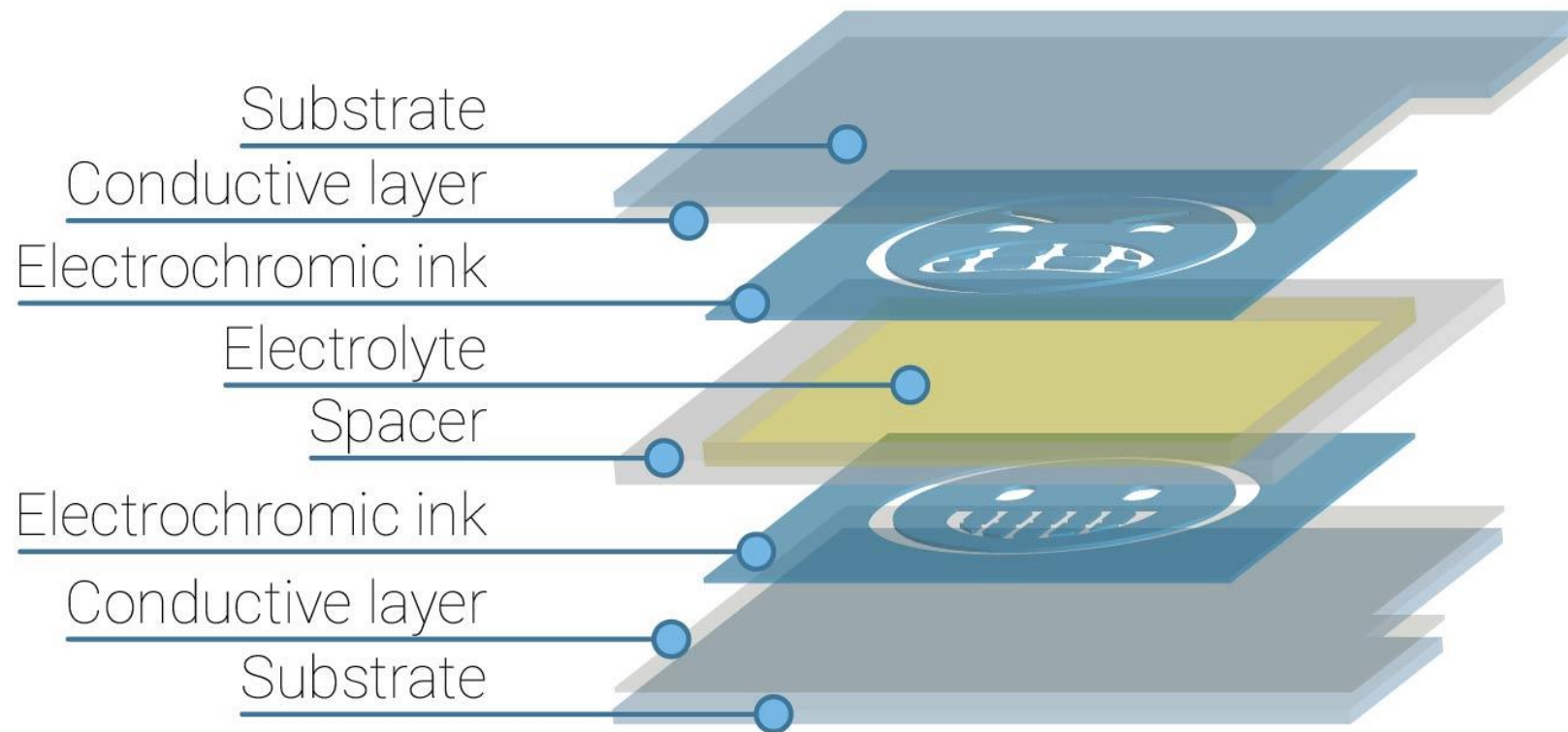
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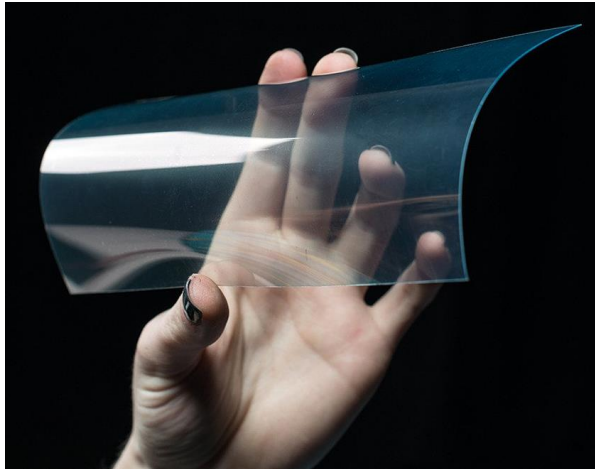
How does it work?



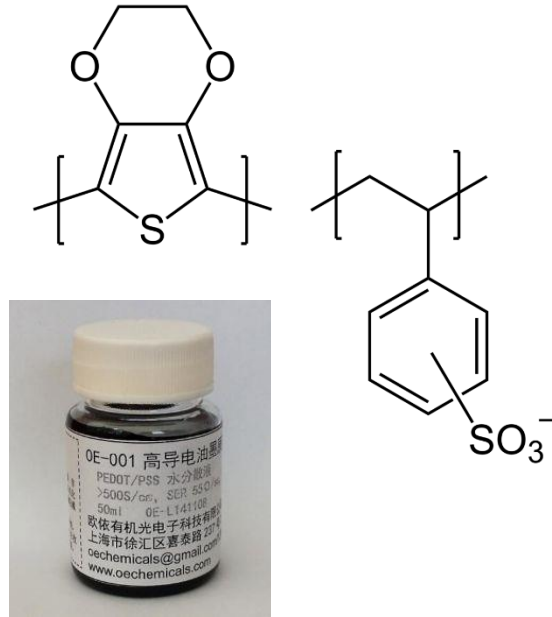
How does it work?



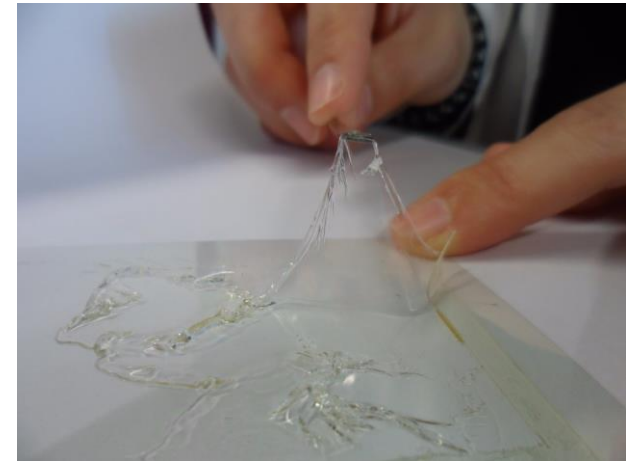
What you need



PET-ITO



PEDOT:PSS



Electrolyte



What you need



Spacermaterial



Copper Tape



Printing



Ink-Jet



Silkscreen



Ynvisible Ink-Kit

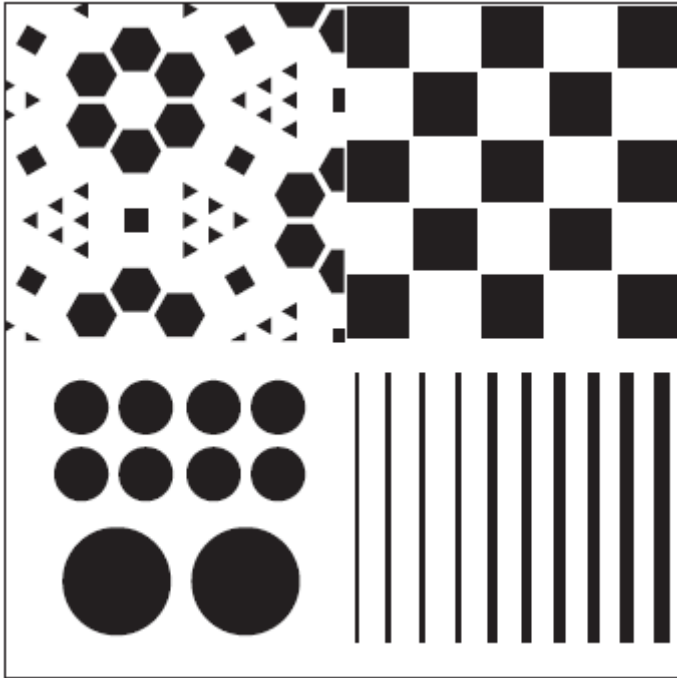


<https://www.ynvisible.com/ec-kit>

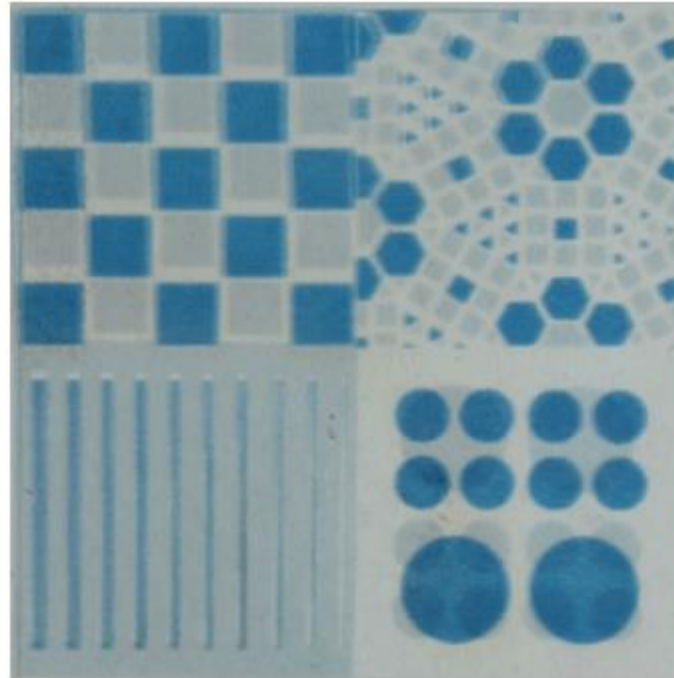


Difference in Printing Methods?

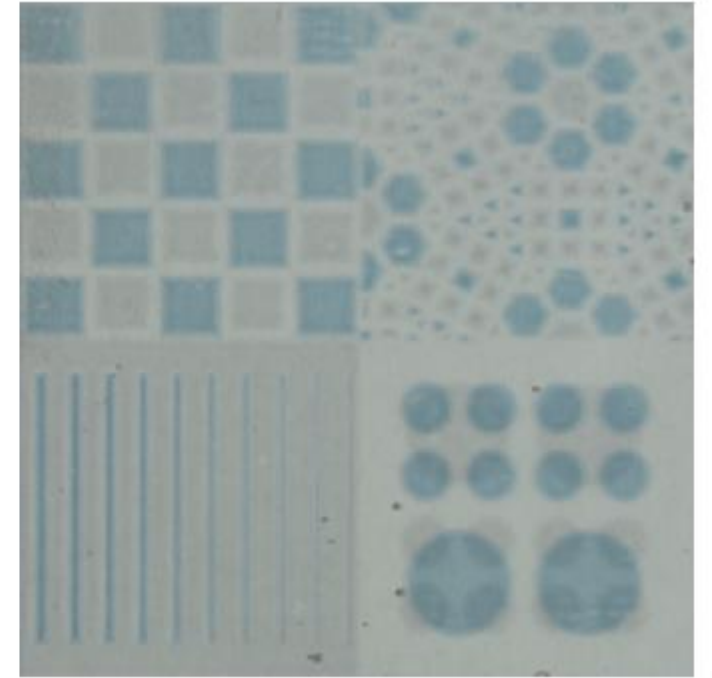
Design



Silkscreen



Ink-Jet



However...

- Ink-Jet printed Fraunhofer "Prussian Blue"



Assembly of the Display

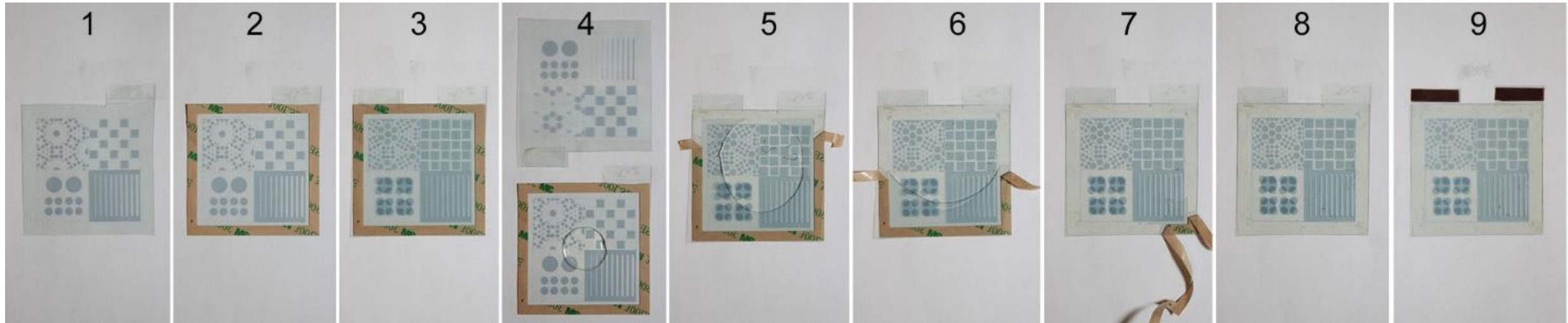


How do we put this together?

- Cut the PET-ITO
- Spacer Alignment
- Add Electrolyte
- Distribute Electrolyte
- Add copper tape & test Display

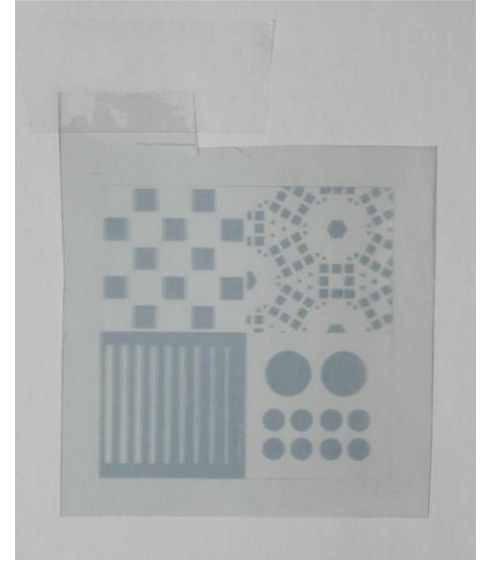


Assembly of the Display



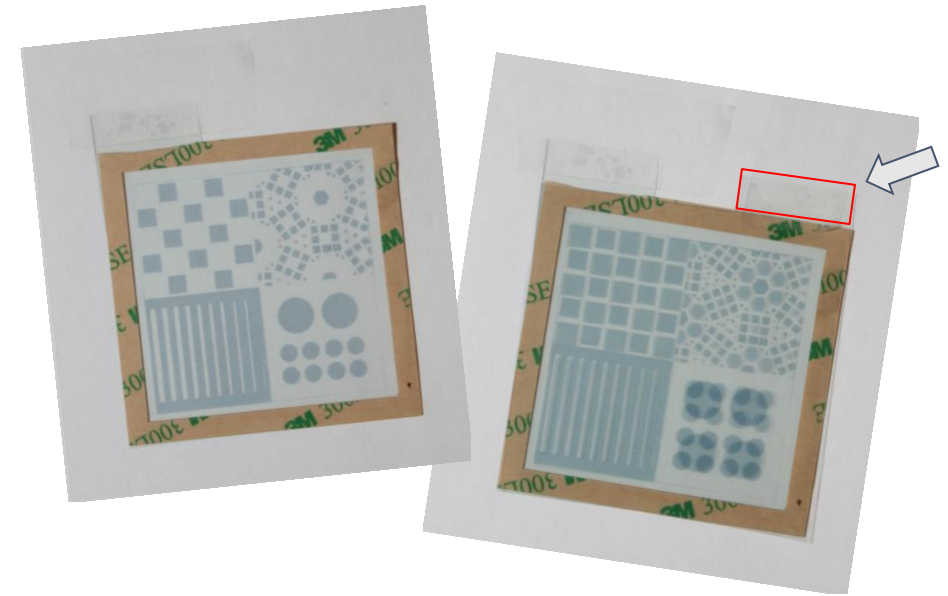
Step 1: Cutting PET-ITO

- Put on gloves
- Cut off excess PET-ITO
 - Try not to touch the printed area
- Stick lead area to something
 - This will keep the side fixed
 - Remember to keep ITO (conductive) side up



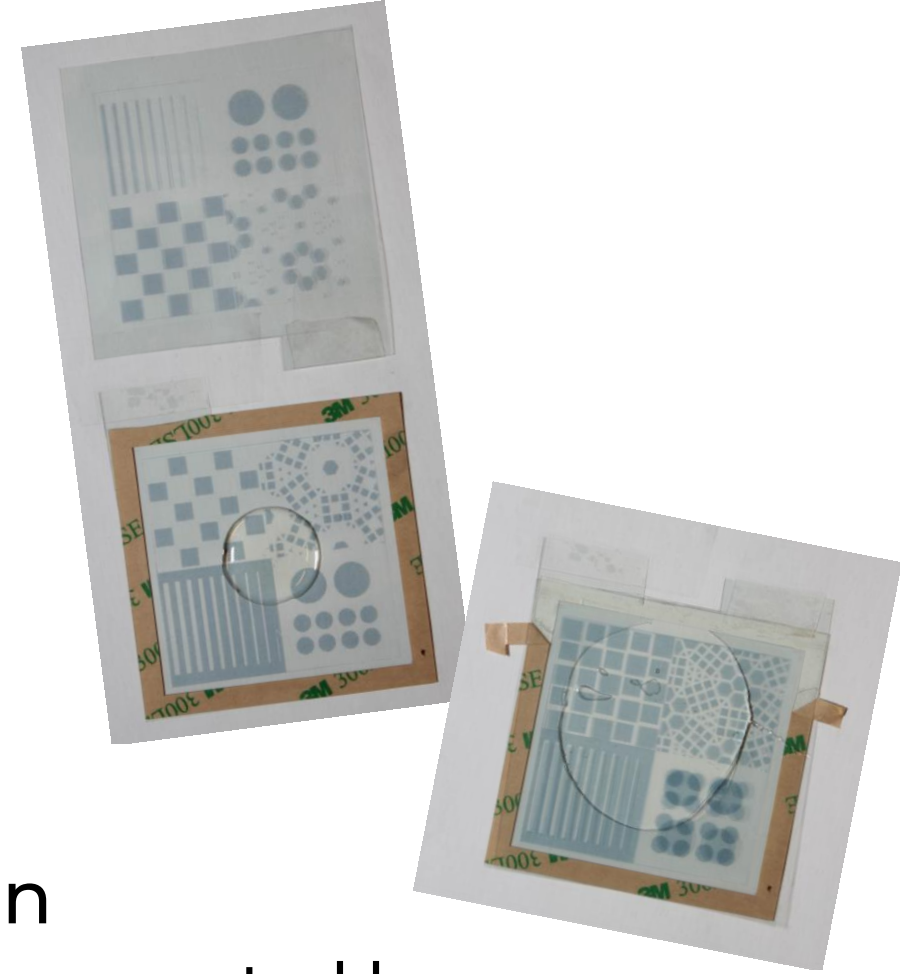
Step 2: Spacer and Alignment

- Add spacer to stuck layer
 - As precise as possible
- Align top with bottom
 - (TIP) Use one hand to keep it in place
- Add tape to top layer lead
 - This will help keep the alignment



Step 3: Add Electrolyte

- Flip top layer over
- Dispense electrolyte
- Remove top part of spacer protection
 - Make sure top parts of the PET-ITO are connected by the spacer before electrolyte reaches edge



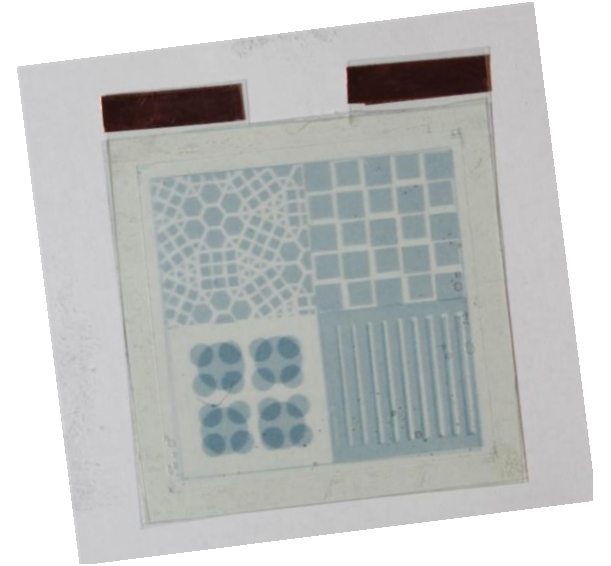
Step 4: Distribute Electrolyte

- Slowly press electrolyte towards edges
- Remove spacer protection as electrolyte is distributed
 - Make sure spacer is adhered before electrolyte reaches it
- Air bubbles will most likely form. Make sure they are moved to one corner and slowly pushed out.



Step 5: Finish Display

- Add copper-tape to leads
- Test with 1.5V (e.g. one AAA Battery)
- If it works? Celebrate!



On YouTube

<https://www.youtube.com/watch?v=NQZ86fj5fMw>





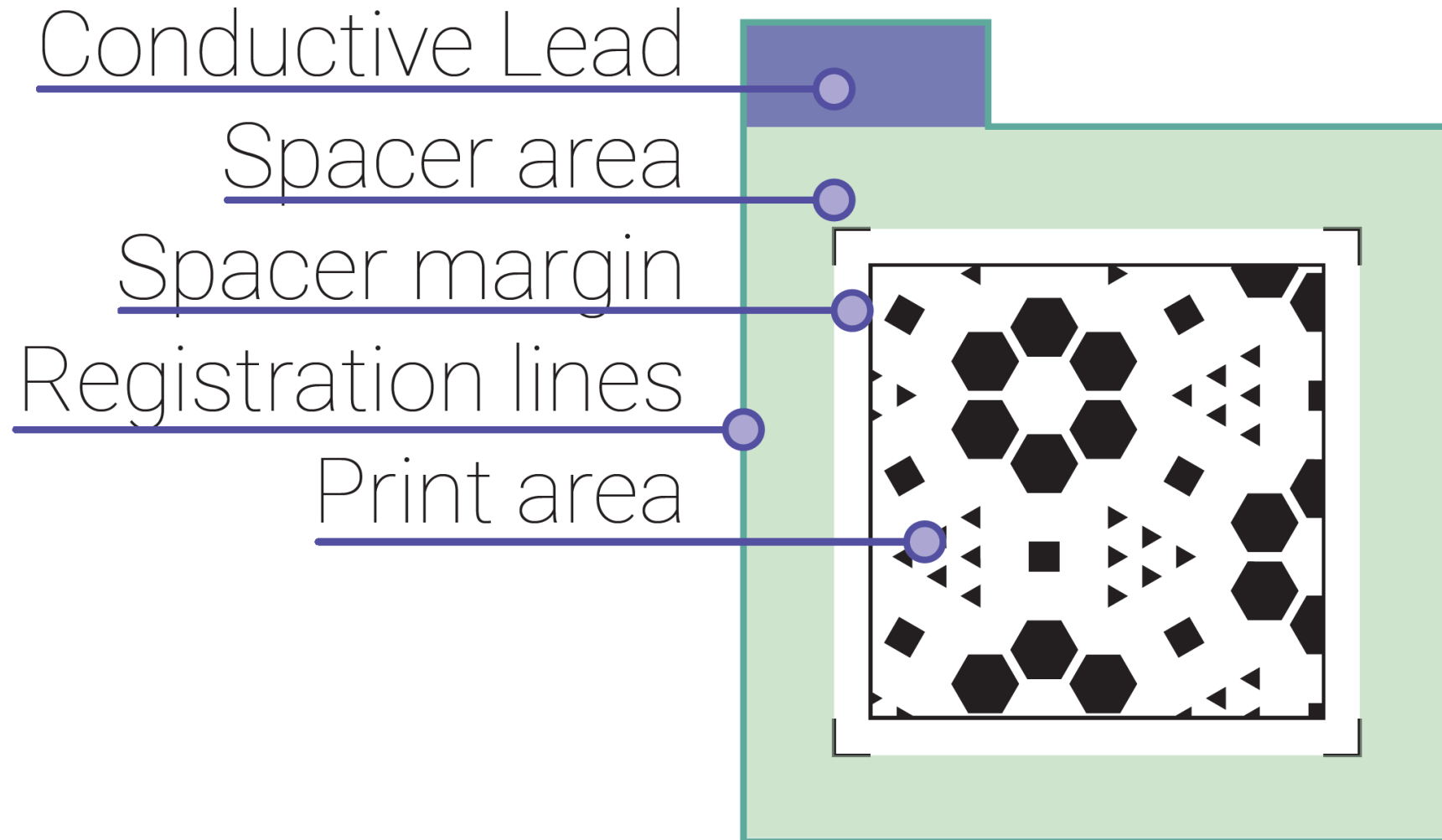
Design of Electrochromic Displays



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Design



Design the display

- One side needs to be flipped!

| Bus 15 - Visse | | | | |
|----------------|----|----|----|----|
| 6 | | 17 | | |
| 7 | | 17 | | |
| 8 | | 17 | | 47 |
| 9 | | 17 | | 47 |
| 10 | 02 | 17 | 32 | 47 |
| 11 | 02 | 17 | 32 | 47 |
| 12 | 02 | 17 | 32 | 47 |
| 13 | 02 | 17 | 32 | 47 |
| 14 | 02 | 17 | 32 | 47 |
| 15 | 02 | 17 | 32 | 47 |
| 16 | 02 | 17 | 32 | 47 |
| 17 | 02 | 17 | 32 | 47 |
| 18 | | 17 | | 47 |
| 19 | | 17 | | 47 |
| 20 | | 17 | | 47 |
| 21 | | 17 | | 47 |
| 22 | | 17 | | 47 |
| 23 | | 17 | | |

| Bus 15 - Visse (Weekend) | | | | |
|--------------------------|--|----|--|----|
| | | 15 | | 6 |
| | | 15 | | 7 |
| | | 15 | | 8 |
| | | 15 | | 9 |
| 45 | | 15 | | 10 |
| 45 | | 15 | | 11 |
| 45 | | 15 | | 12 |
| 45 | | 15 | | 13 |
| 45 | | 15 | | 14 |
| 45 | | 15 | | 15 |
| 45 | | 15 | | 16 |
| 45 | | 15 | | 17 |
| 45 | | 15 | | 18 |
| 45 | | 15 | | 19 |
| | | 15 | | 20 |
| | | 15 | | 21 |
| | | 15 | | 22 |
| | | 15 | | 23 |



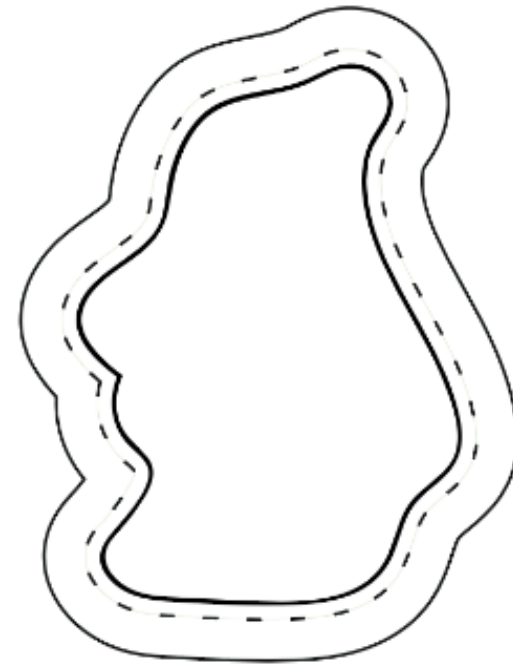
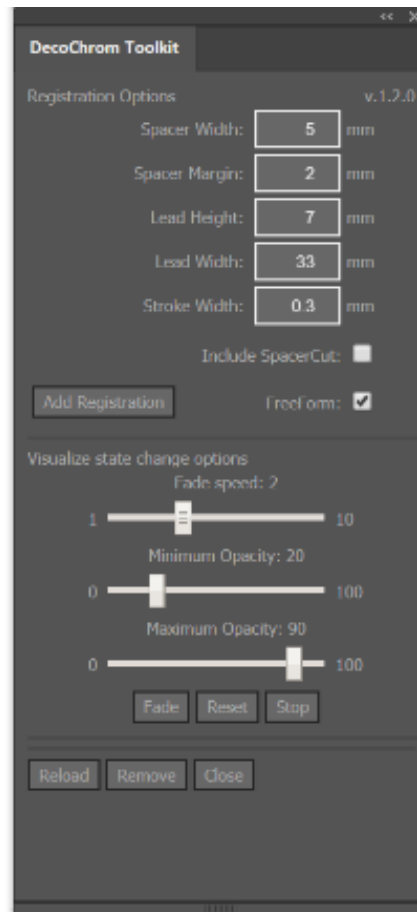
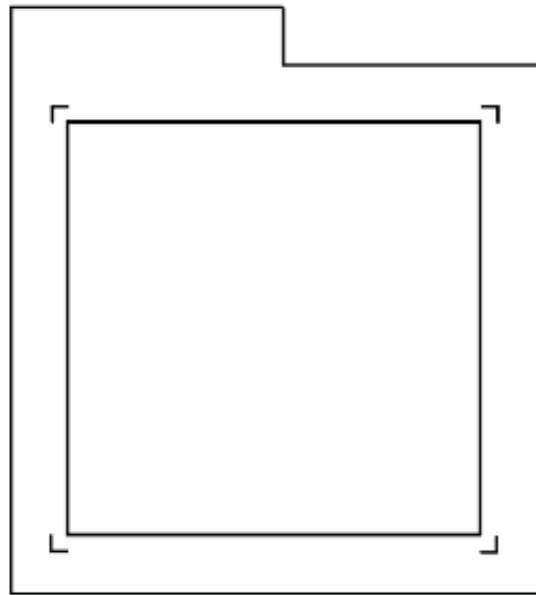
What to take into account?

- Space between ink electrodes vs speed
- Size of ink electrodes
- **Balancing the ink on both sides**



Adobe Illustrator Plug-In

<https://github.com/DecoChrom/IllustratorExtension>



Co-Planar?

