



NEW ELECTRONICS: FLEXIBLE, ORGANIC, PRINTED

PAUL HEREMANS



IMEC – HOLST CENTER

imec

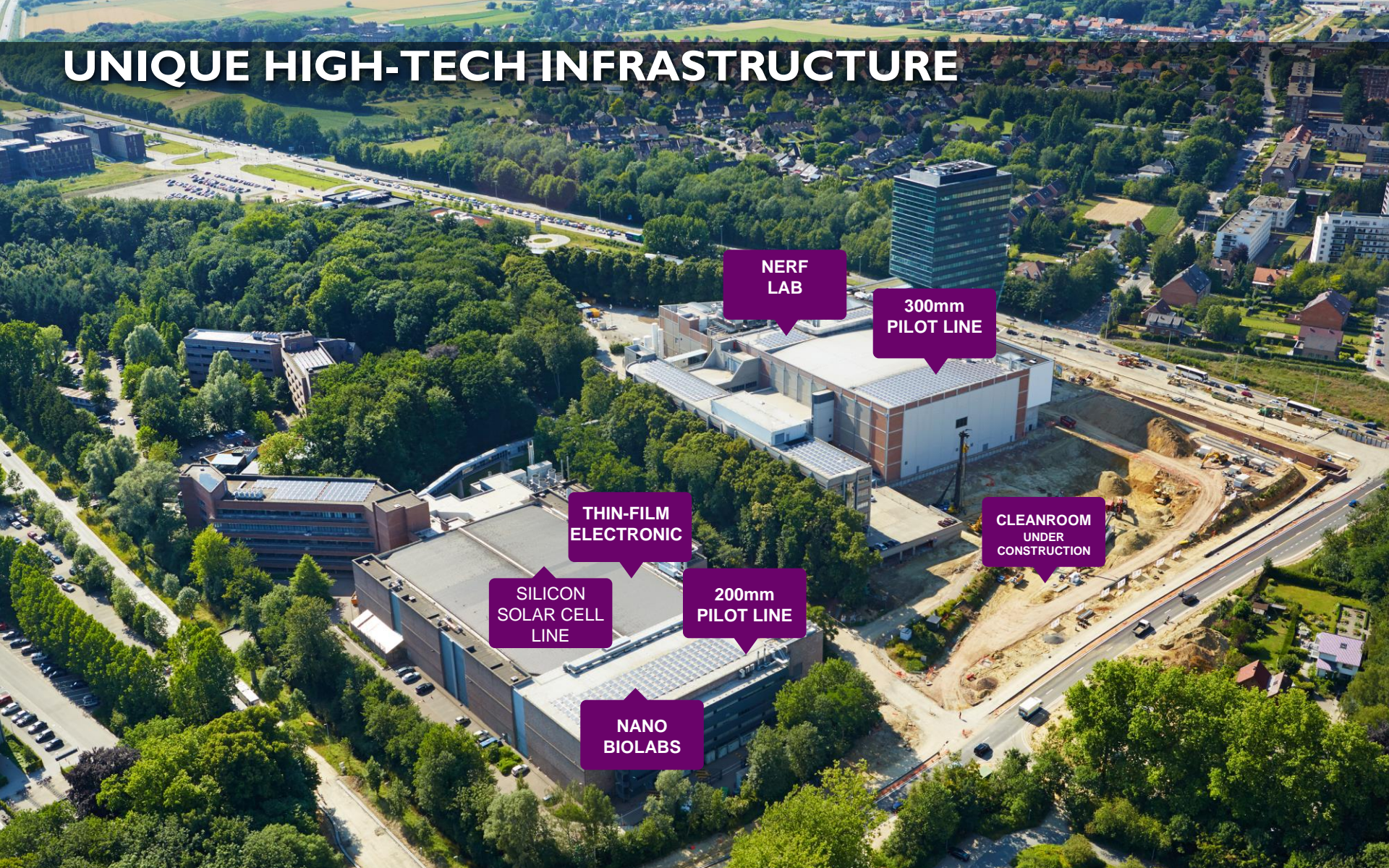


Our mission

**world-leading research
in electronics for ICT, healthcare and energy
with world-wide industry**



UNIQUE HIGH-TECH INFRASTRUCTURE



NERF
LAB

300mm
PILOT LINE

THIN-FILM
ELECTRONIC

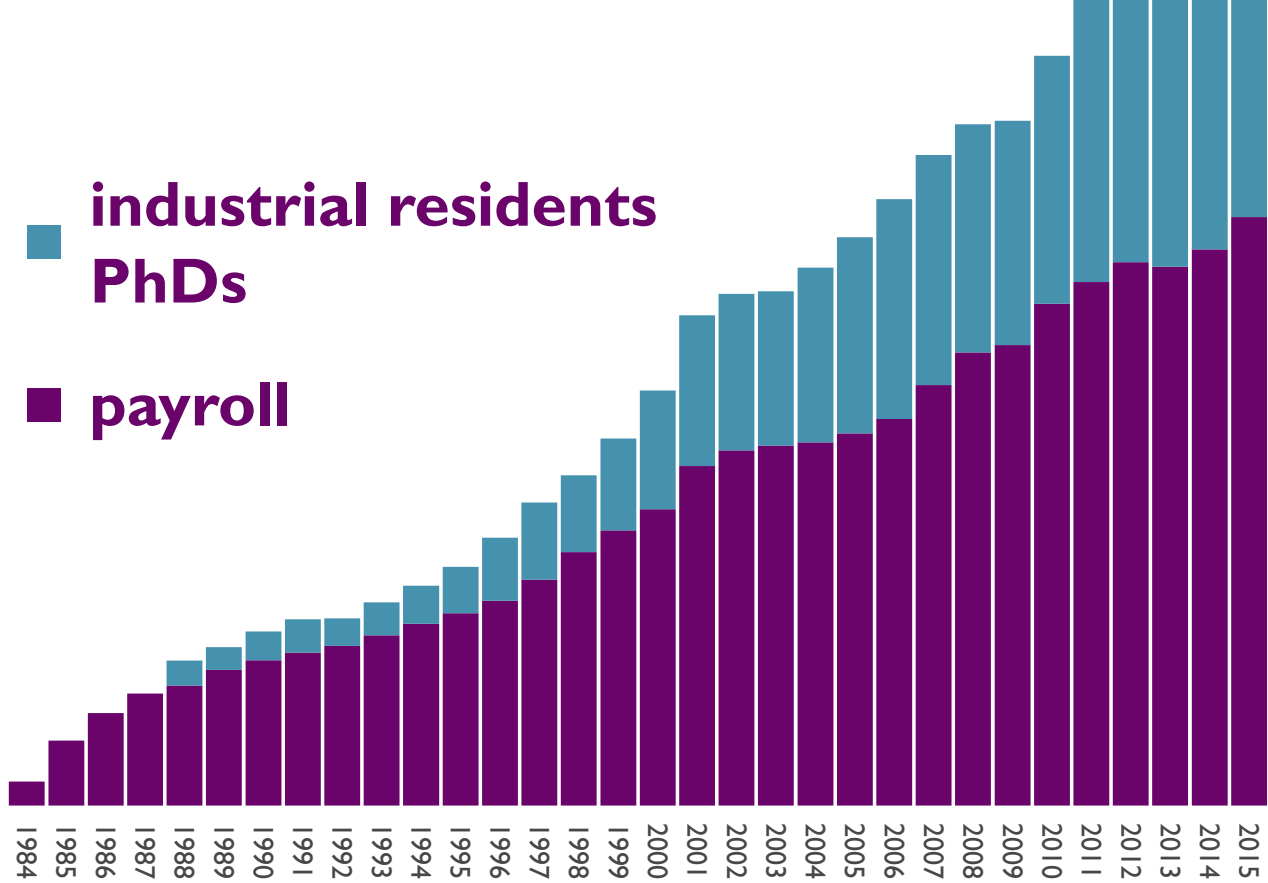
CLEANROOM
UNDER
CONSTRUCTION

SILICON
SOLAR CELL
LINE

200mm
PILOT LINE

NANO
BIOLABS

employees



2015: ~2300

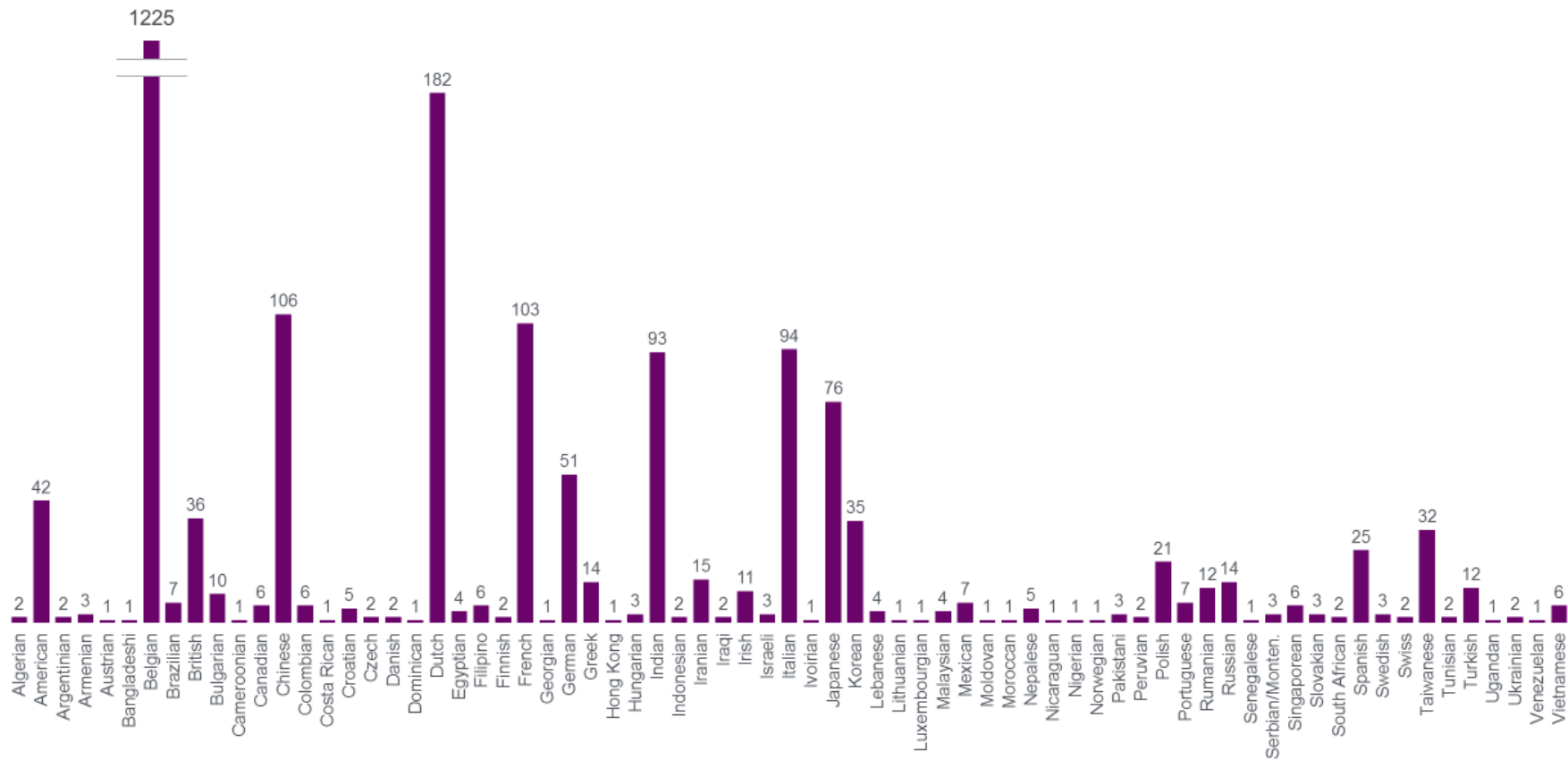
Payroll: 1500

PhD's: 300

Industrial

residents: 500

OUR ENGINEERS COME FROM ALL OVER THE WORLD: 71 NATIONALITIES





INTERNET OF THINGS

Sensing &
connectivity



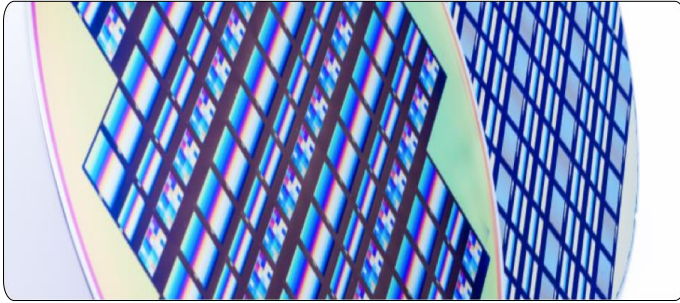
INTERNET OF HEALTHY THINGS

Life sciences



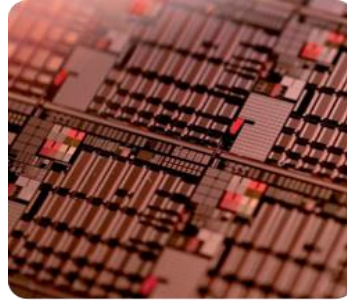
INTERNET OF POWER

Photovoltaics
Solid-state Batteries



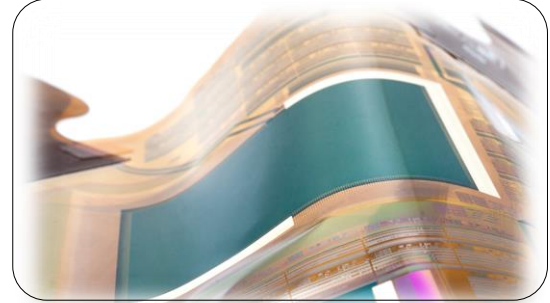
CORE CMOS

Lithography Devices Interconnects



HETEROGENEOUS on CMOS

MEMS, Sensors,
Photonics



FLEXIBLE ELECTRONICS

Displays IoT circuits Sensors

“PLASTIC” REFERS TO MECHANICAL PROPERTIES

shatterproof



2D bendable



lightweight



“PLASTIC” LEADS TO INTEGRATION INTO OBJECTS

shatterproof



2D bendable



Univ Tokyo

lightweight



Univ Tokyo

textile



imec

stretch

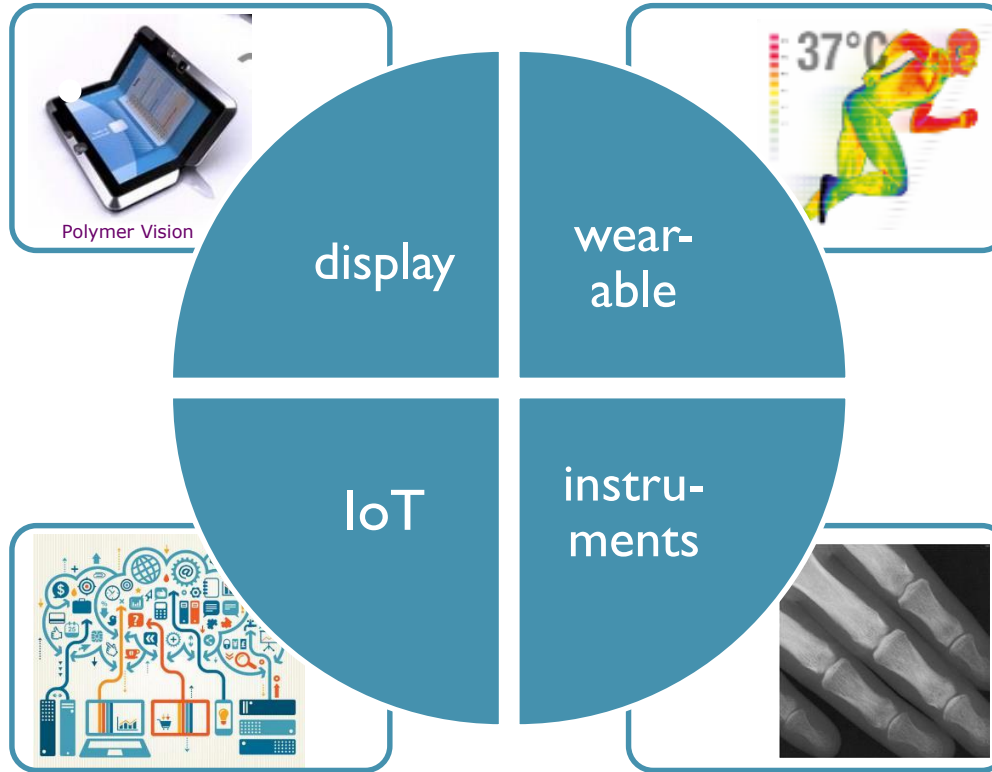


holst

paper



...WHICH LEADS TO NEW APPLICATION POSSIBILITIES



APPLICATIONS FOR FLEXIBLE ELECTRONICS

Flexible Displays

- First displays on plastic are on the market

LG G Flex
(Q1 2014)



SAMSUNG Galaxy S5 curved
(Q1/2014)



- Flexible displays are in development

APPLICATIONS FOR FLEXIBLE ELECTRONICS

Flexible Displays

- First displays on plastic are on the market

LG G Flex
(Q1 2014)



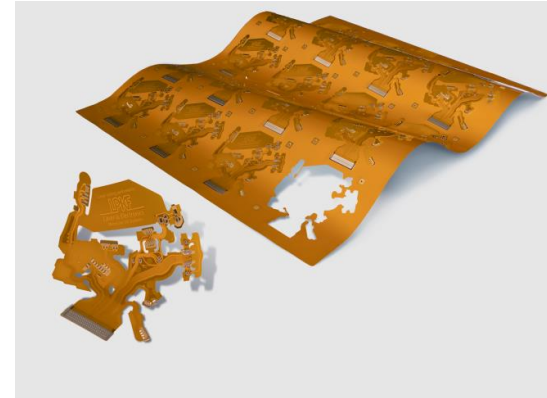
SAMSUNG Galaxy S5 curved
(Q1/2014)



- Flexible displays are in development

Electronics in flexible form factor

- Rigid electronics on flexible substrate is on the market

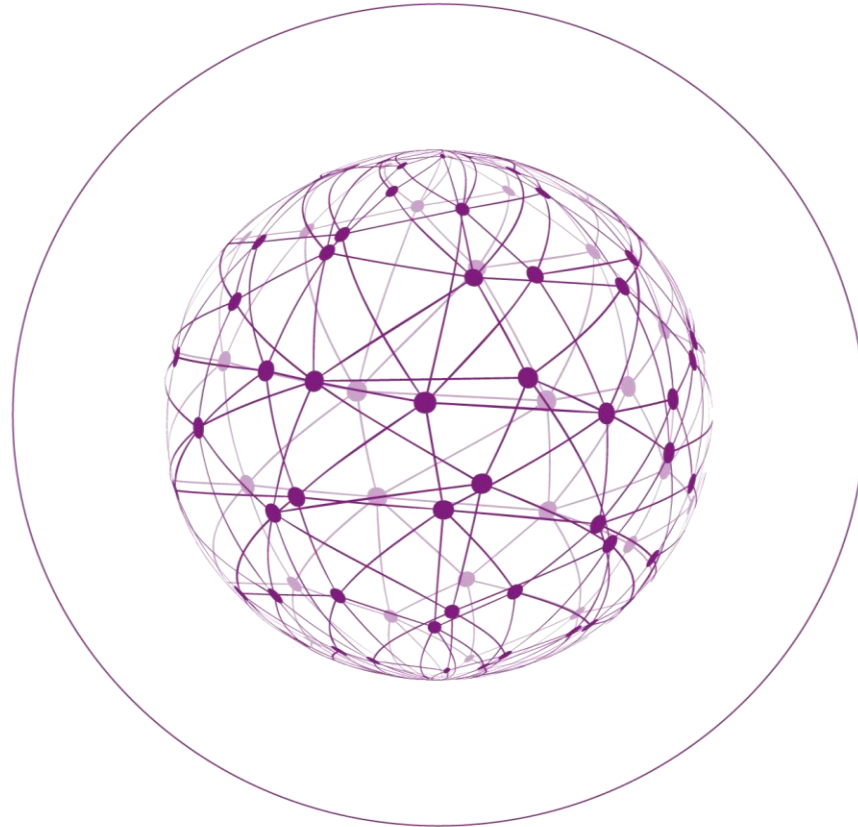


- Flexible electronics is in development
It can be done with technology similar as display backplane

FLEXIBLE ELECTRONICS PARTNERSHIP WITH ARTEK ELECTRONICS



>50 BILLION CONNECTED DEVICES BY 2020





Value



80 million
cars/year



2000 million
devices/year



80,000 million
pieces/year



10,000,000 million
packages/year

Value ↑



80 million
cars/year



2000 million
devices/year



80,000 million
pieces/year

\$100+ billion
OPPORTUNITY
for item level
electronics
10,000,000
packages/year

APPLICATION CASE: RFID IN RETAIL



APPLICATION CASE: LOGISTICS



APPLICATION CASE: BRAND PROTECTION



APPLICATION CASE: SMART PACKAGING



APPLICATION CASE: SKIN CARE MONITORING



WHAT IS NEEDED TO BRING THIS TO REALITY?

WHICH TECHNOLOGY?



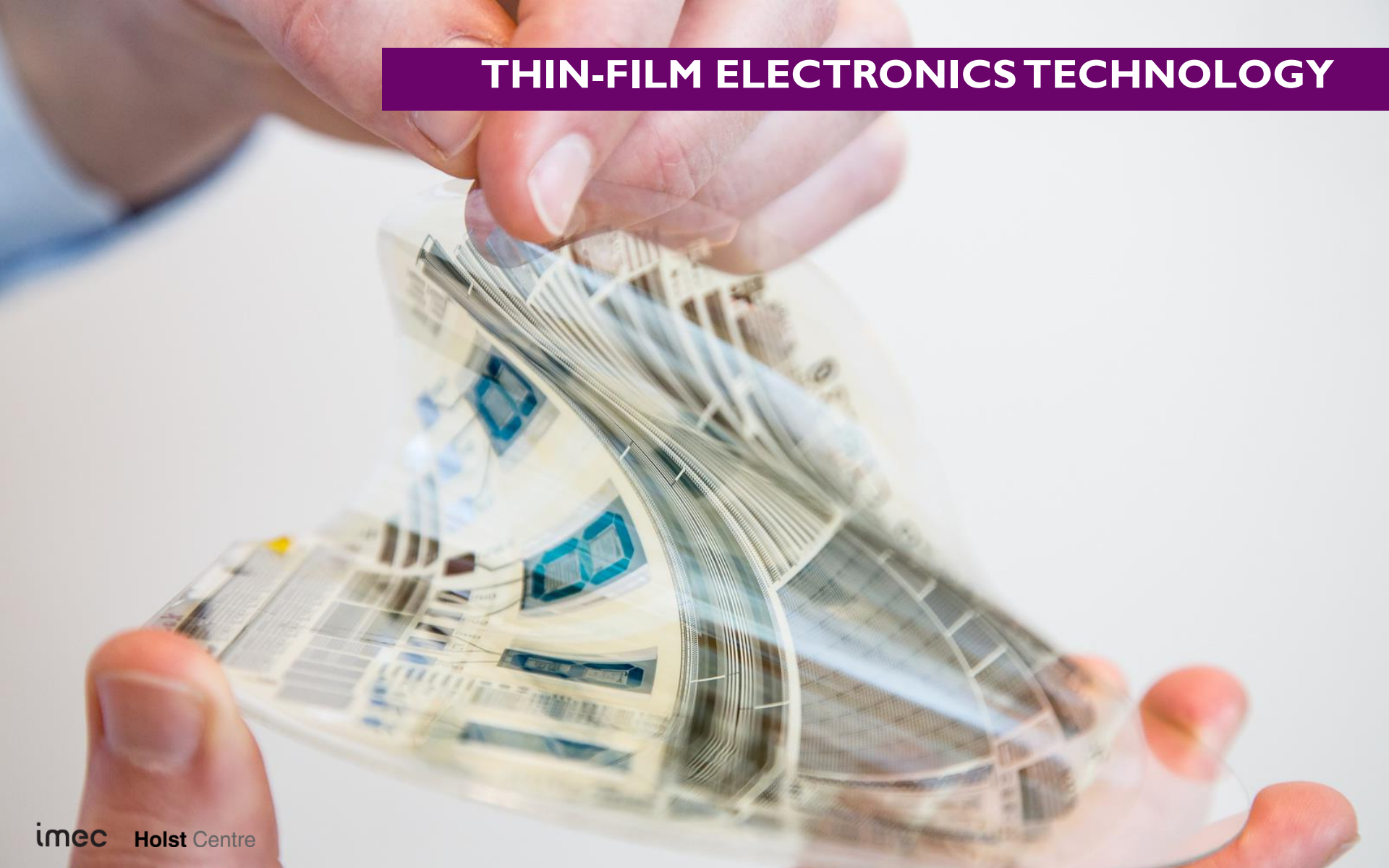
Trillions devices

Disposable

Unusual
form-factors

Multifunctional

THIN-FILM ELECTRONICS TECHNOLOGY



THIN-FILM ELECTRONICS TECHNOLOGY



Trillions devices

Disposable

**Unusual
form-factors**

Multifunctional

Large-area manufacturing

- Flat panel display process
- Very large volumes
- Relatively low cost

Form factor

- 25 μ m plastic substrate

Monolithic integration

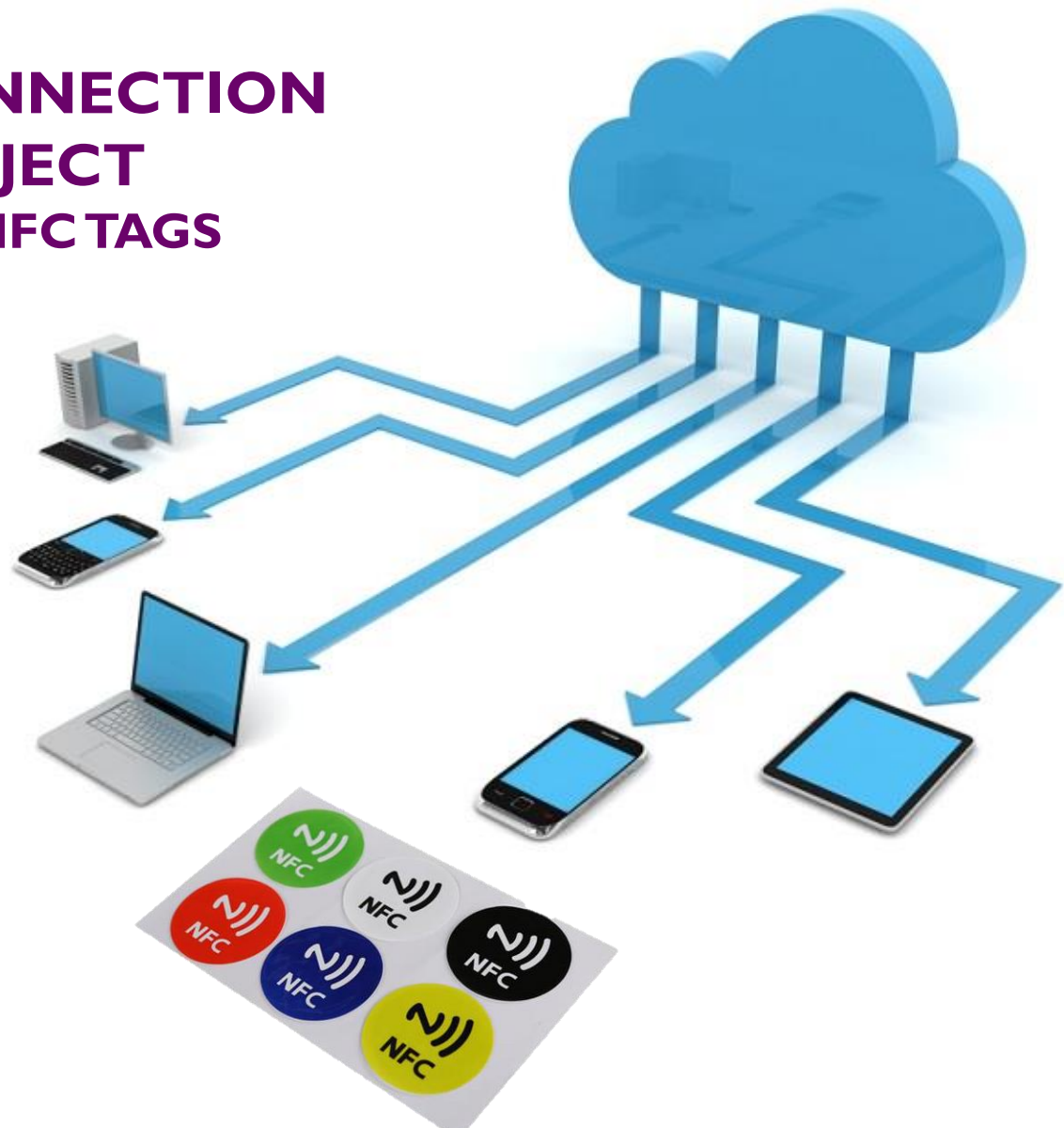
- Sensors, display segments, ...

MULTIFUNCTIONAL THIN-FILM COMPONENTS



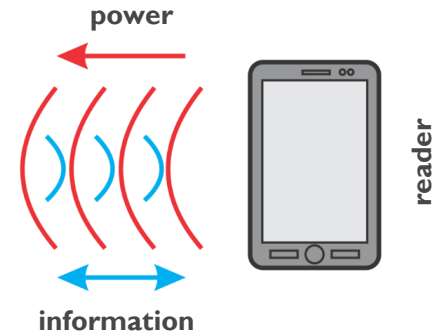
- Sensors
- Logic
- Memory
- Battery
- Display
- Wireless

WIRELESS CONNECTION FOR EVERY OBJECT USING PLASTIC NFC TAGS



ISO 14443 TAG IN DEVELOPMENT

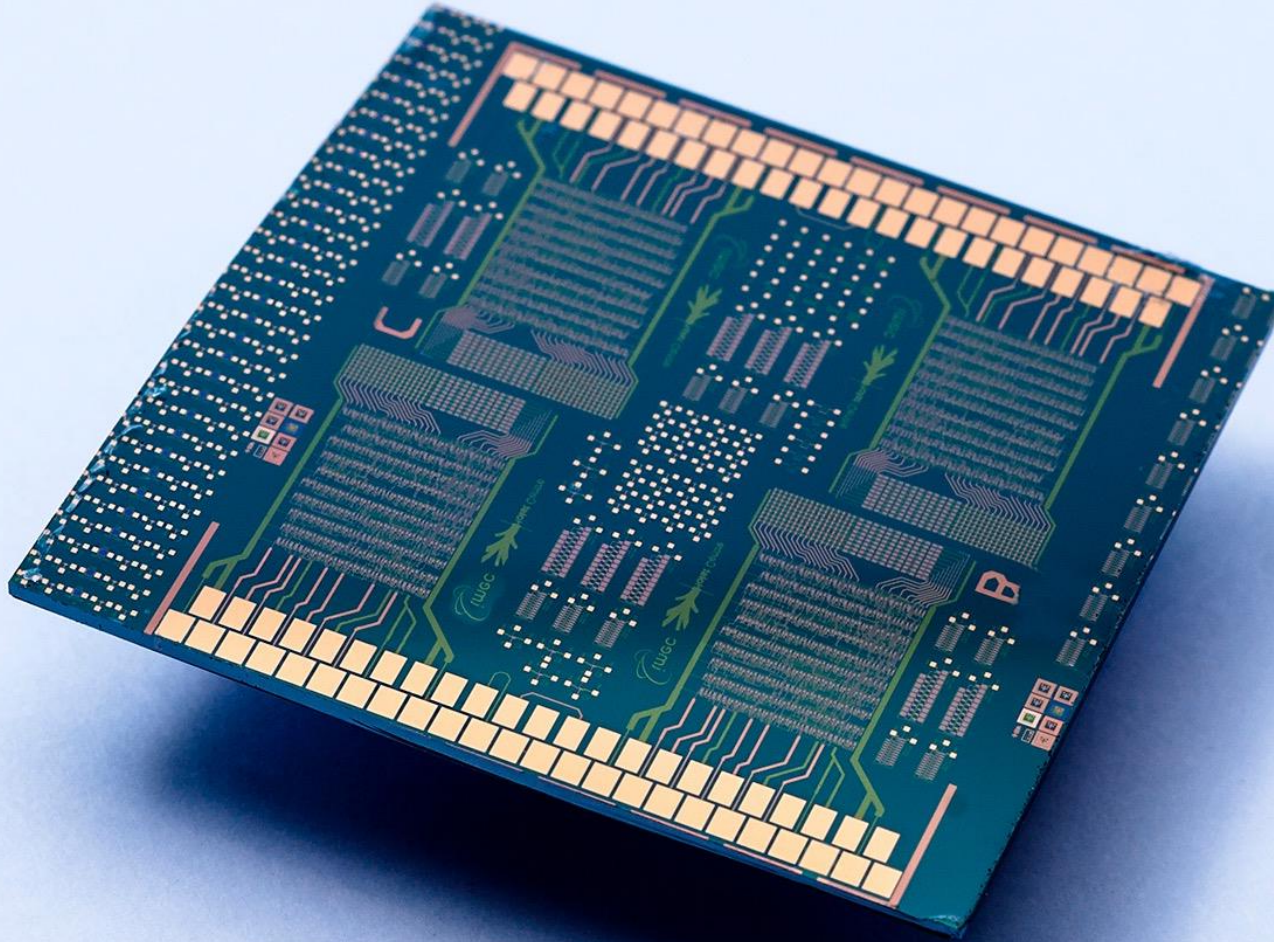
February 22-26, 2015
February 2016



“IGZO thin-film transistor based flexible NFC tags powered by commercial USB reader device at 13.56MHz”

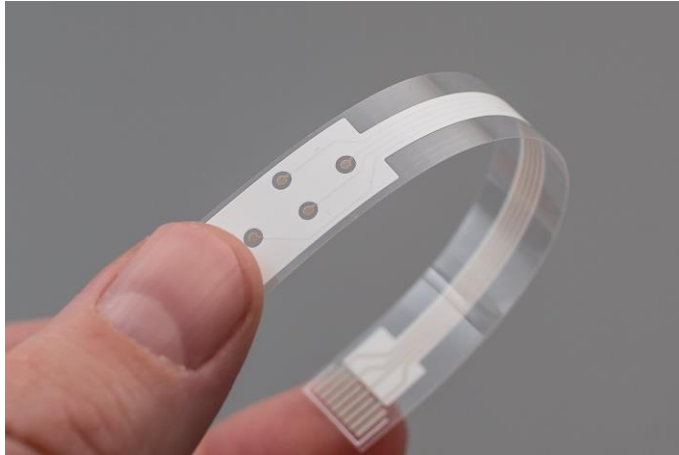
PROCESSING POWER FOR THE IOE

with inkjet print-programmable memory
p-type organic
n-type oxide
low T



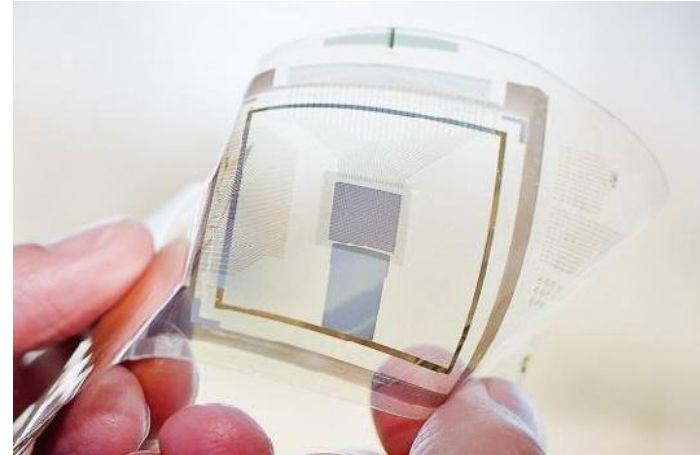
THIN-FILM SENSORS

Thin-film ion sensors



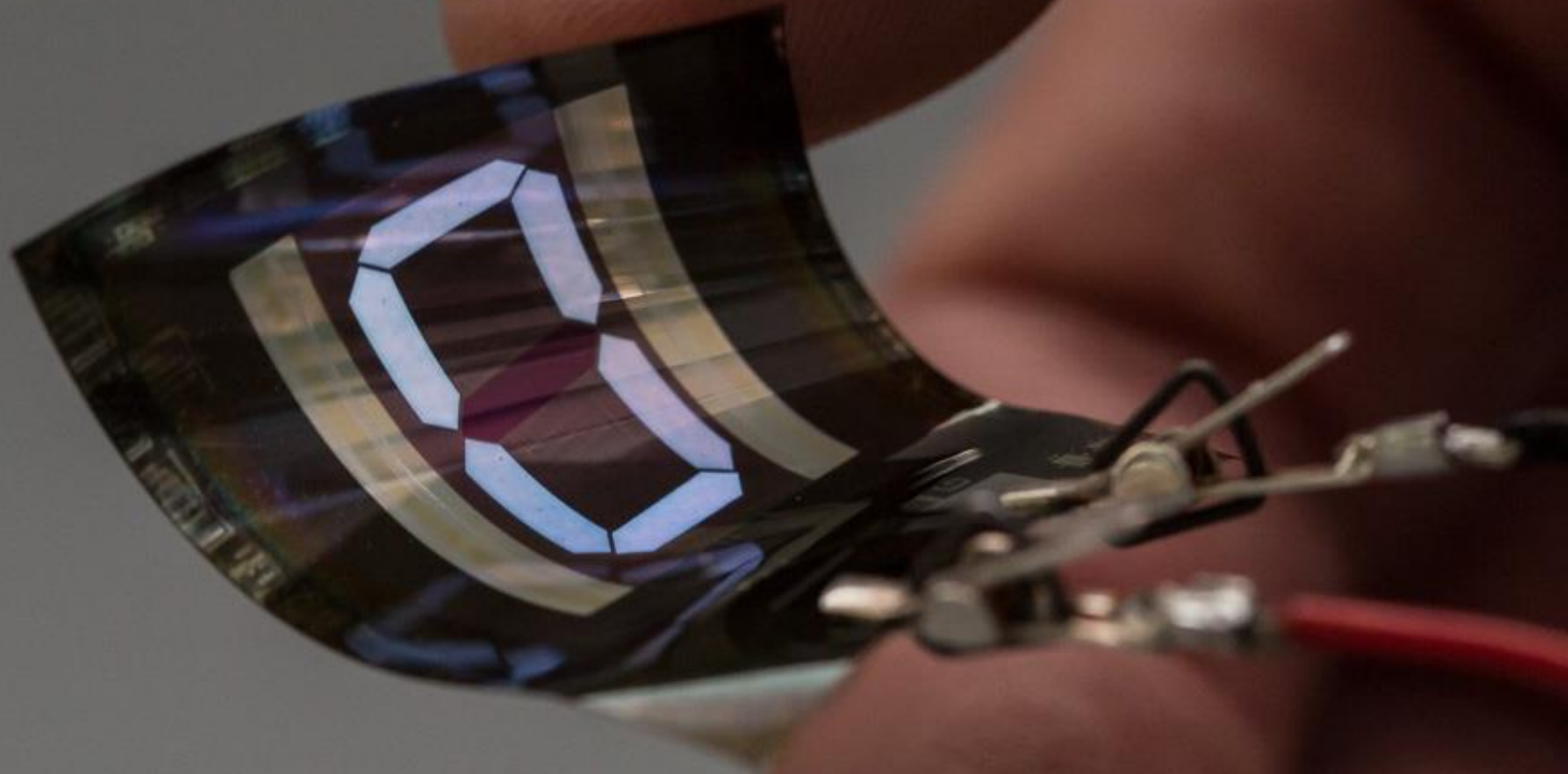
- Printed solid-state ion-selective electrodes
- pH, Cl⁻, Na⁺, K⁺
- pH: 2-10 pH range, 0.1 accuracy

Thin-film photodetectors



- Quantum efficiency @ 550nm
- Linear response down to 3.5 nW/cm²
- Dark current < 100pA/cm²

THIN-FILM DISPLAY SEGMENTS



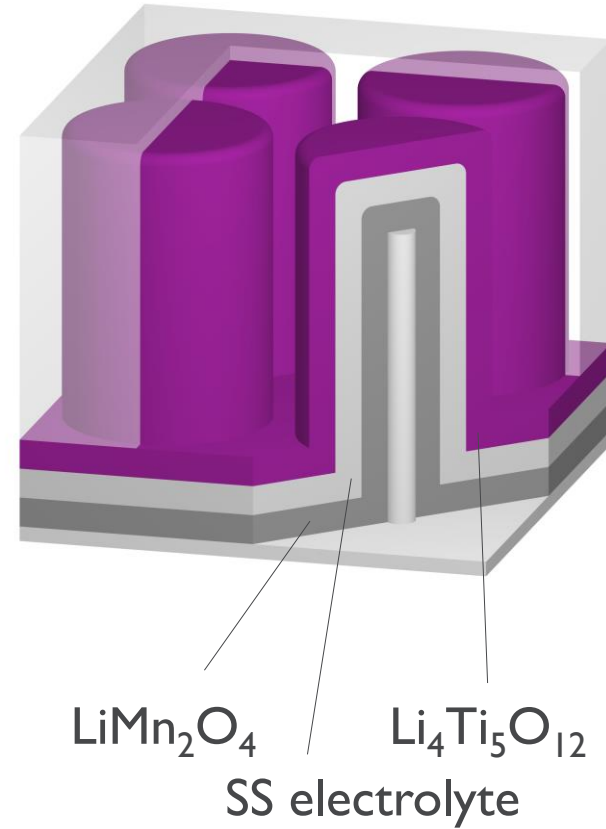
“CHIPLESS” COUNTER



THIN-FILM SOLID-STATE BATTERY



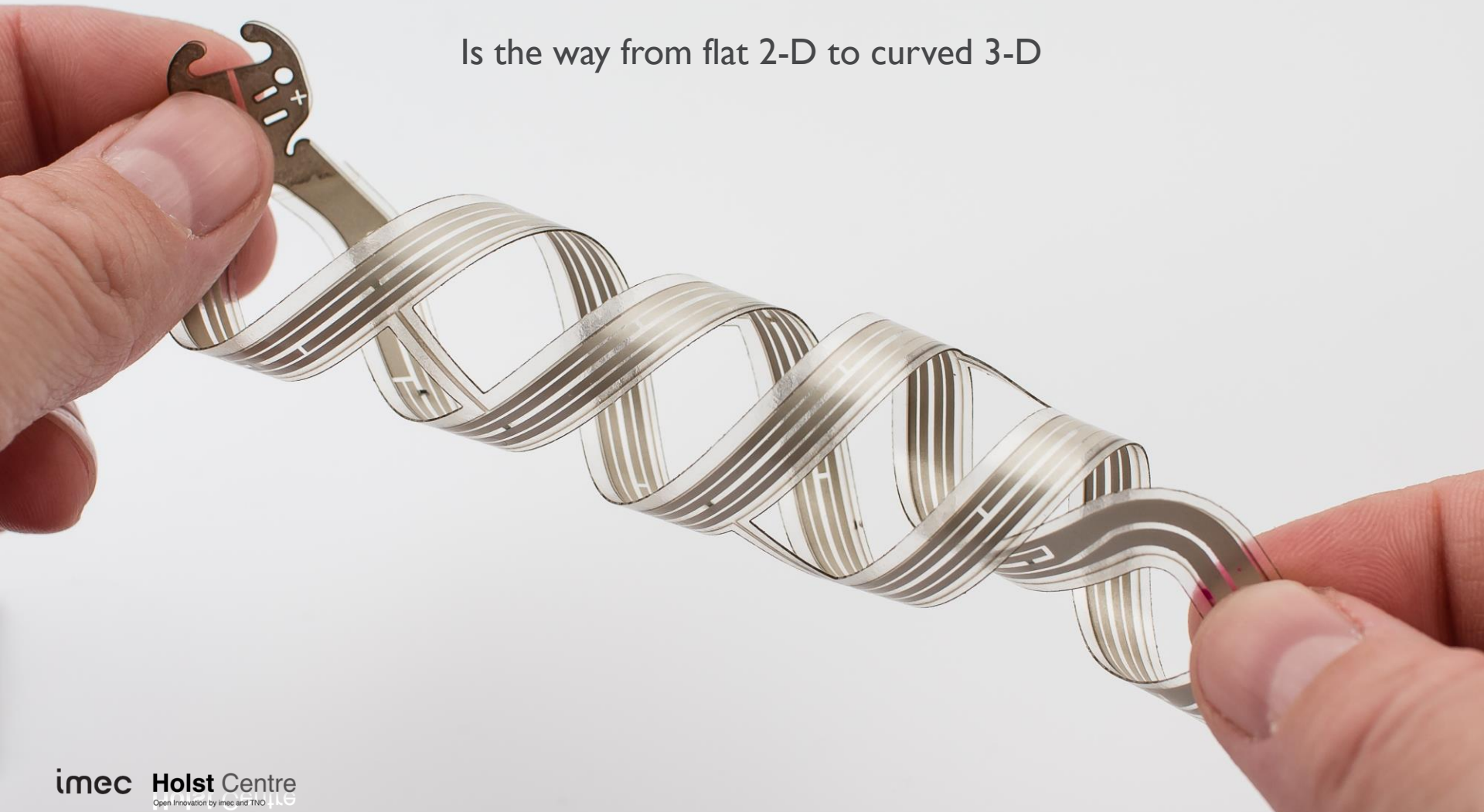
1st generation thin-film
solid-state battery



**FROM ELECTRONICS ON PLASTIC SHEET
TO ELECTRONICS IN OBJECT**

LASER-SHAPING OF THIN PLASTIC SUBSTRATE

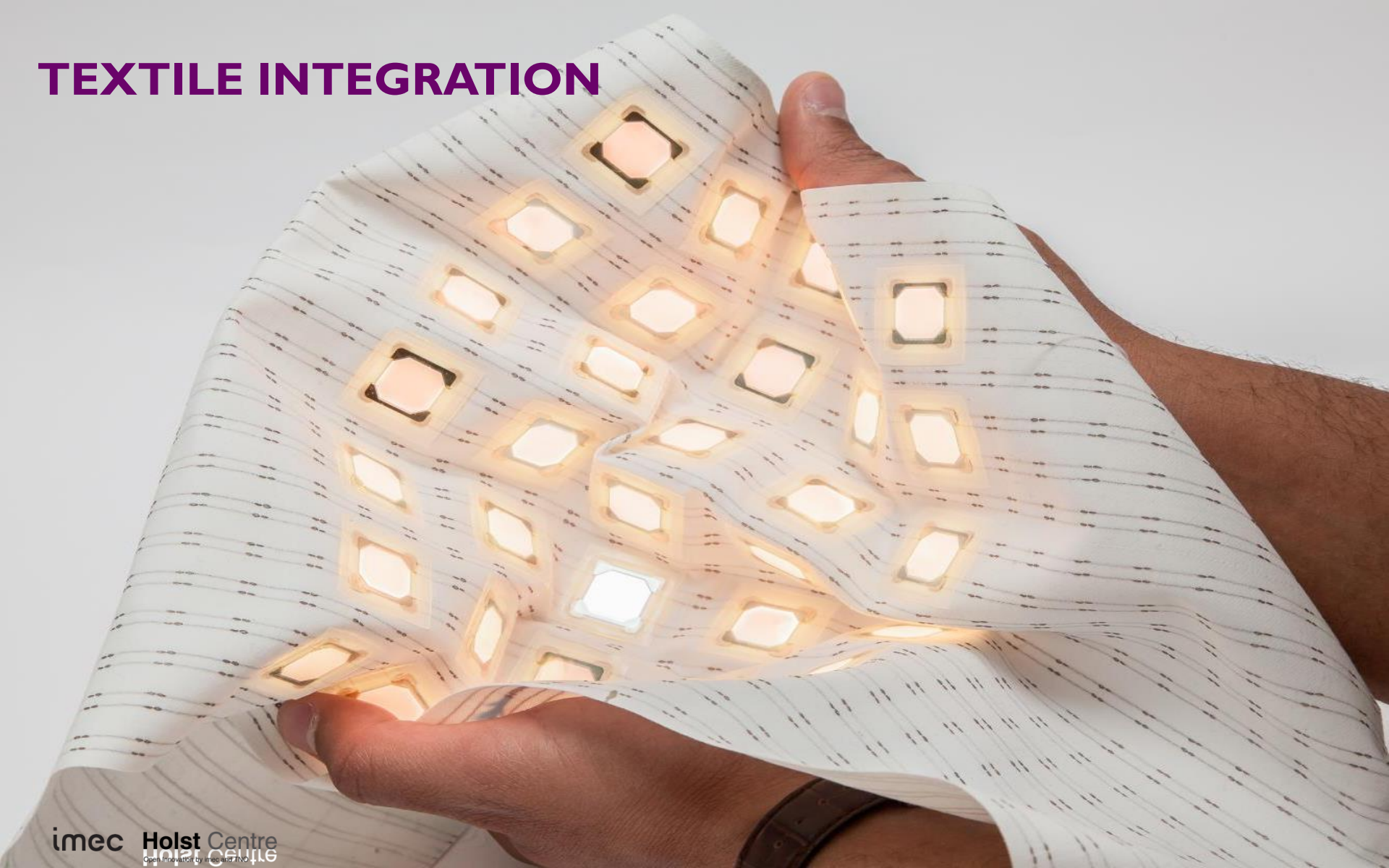
Is the way from flat 2-D to curved 3-D



TEXTILE INTEGRATION



TEXTILE INTEGRATION



MOLDED THERMOPLASTIC



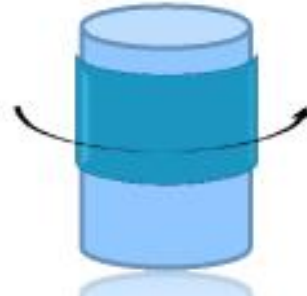
FROM FLEXIBLE TO STRETCHABLE

WHY



Rigid Electronics

0-D flex



Flexible Electronics

1-D flex

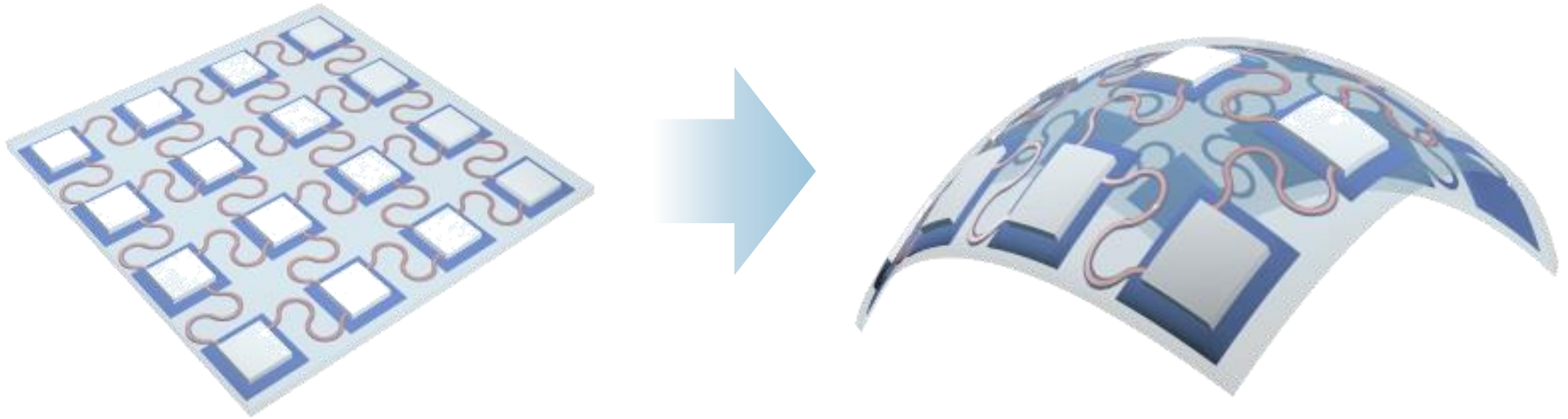


Conformable Electronics

2-D flex

HOW TO STRETCH ELECTRONICS

Functional islands, connected with meander-based stretchable interconnects, embedded in a stretchable rubber



REALIZATION OF STRETCHABLE DISPLAY

>7000 Meander

Integration of

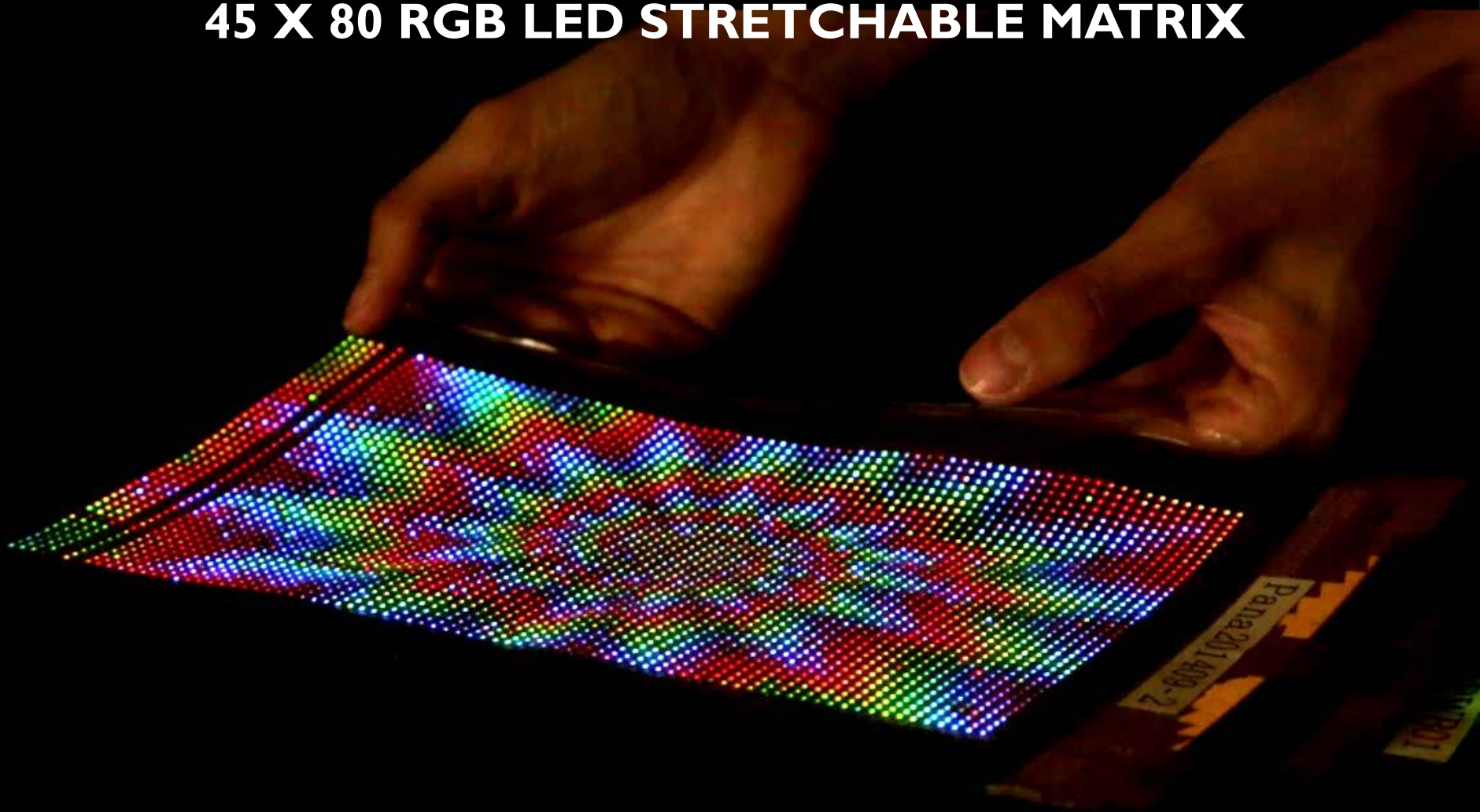
| Item | value |
|--------------|----------------------------|
| Pixel Number | 45RGB (H) x 80 (V) |
| Resolution | 3 mm pitch (8.5 ppi) |
| LED used | SMLP34RGB2W SMLP36RGB2W |
| Driving | Passive |



Stre

Stretchable display after flexbonding of driver circuit

45 X 80 RGB LED STRETCHABLE MATRIX



**THANK YOU
FOR YOUR ATTENTION**

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FOR iOS & ANDROID
WEBSITE MAGAZINE.IMEC.BE
AVAILABLE IN ENGLISH & DUTCH

