

save energy keep track anticipate
lower cost save time stay tuned
improve performance
feel secure

Stretching the Limits of Printed Electronics

Marc Koetse

Holst Centre

Integration technologies for flexible systems



Presentation overview

1. Who we are and what we do
2. First stretch: Thin and flexible smart devices
3. Second stretch: What if flexible is not enough?
4. Third stretch: ...



Holst Centre Fundamentals

- **Independent, with reputed parents**
 - Founded by **IMEC** Belgium and **TNO** The Netherlands
 - Operational since **2006** (HTC, Eindhoven)
- **Working with our partners**
 - Staff of 170 researchers
 - Involving strong groups of mother organisations
 - 70 resident researchers from industry and universities
- **Shared research on**
Flexible electronics and
wireless transducer systems





OLED Lighting

Organic solar cells

Rollable displays

Flexible smart devices

The people involved

- **Integration technologies for flexible systems (Holst/TNO)**
- **Centre for Microsystems Technology (Holst/imec Gent)**
- **Printed conductive structures (Holst/TNO)**
- **Patterning technologies for flexible systems (Holst/TNO)**
- **Ultra low-power sensors (Holst/imec-nl)**
- **Integration Team WATS (Holst/imec-nl)**

Mission

**Apply Holst Centre technologies
for functional prototypes in the
field of hybrid and wearable
electronic applications for
partners and customers**

Presentation overview

1. Who we are and what we do
2. First stretch: Thin and flexible smart devices
3. Second stretch: What if flexible is not enough?
4. Third stretch: ...



Smart Devices



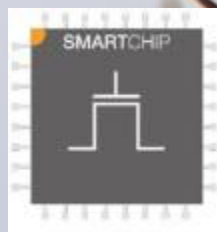
sensing



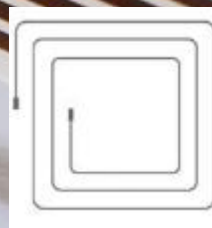
radio



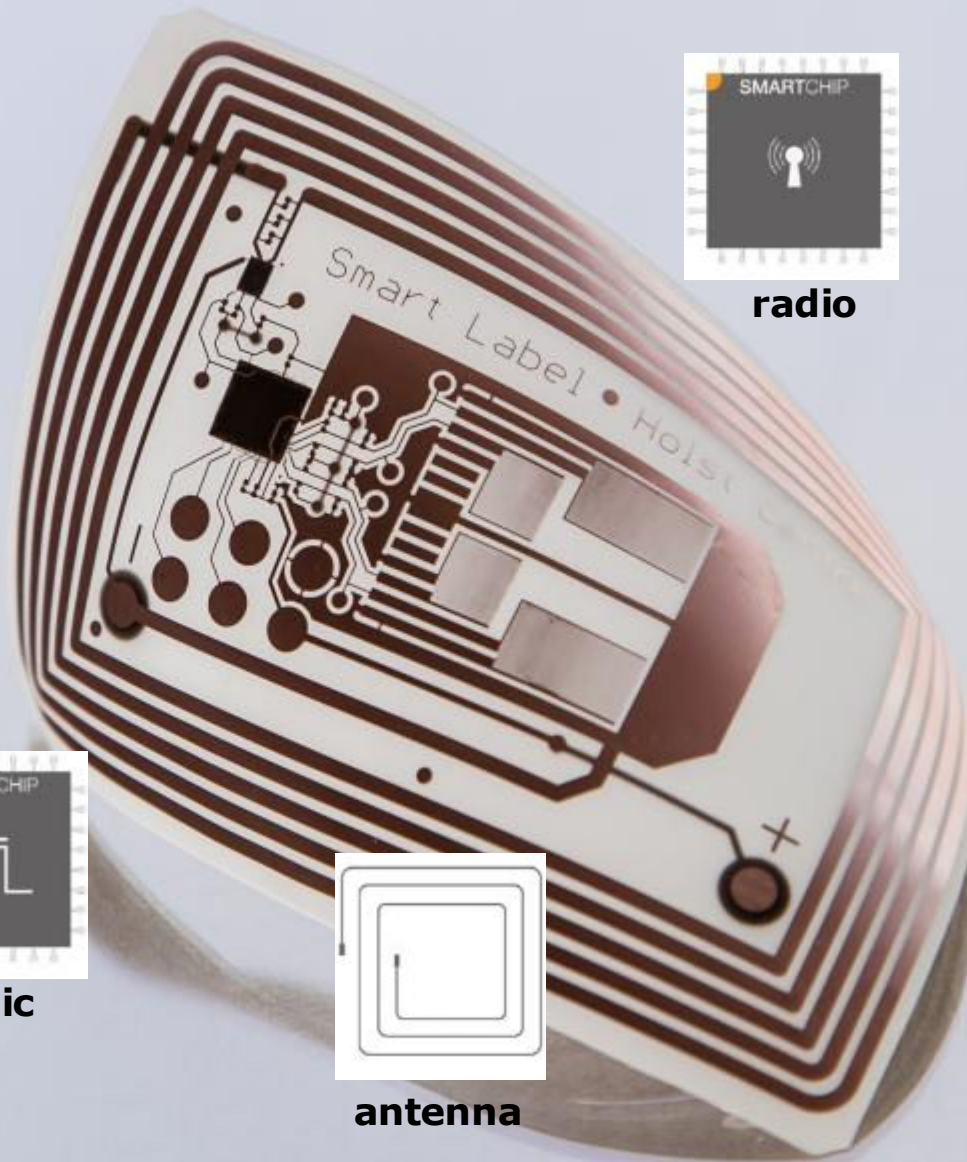
power



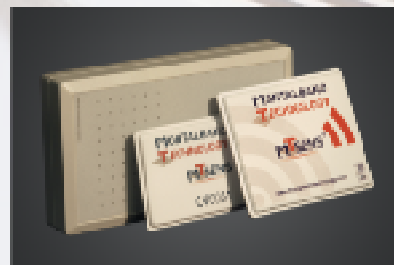
logic



antenna



Slow evolution, certainly no revolution



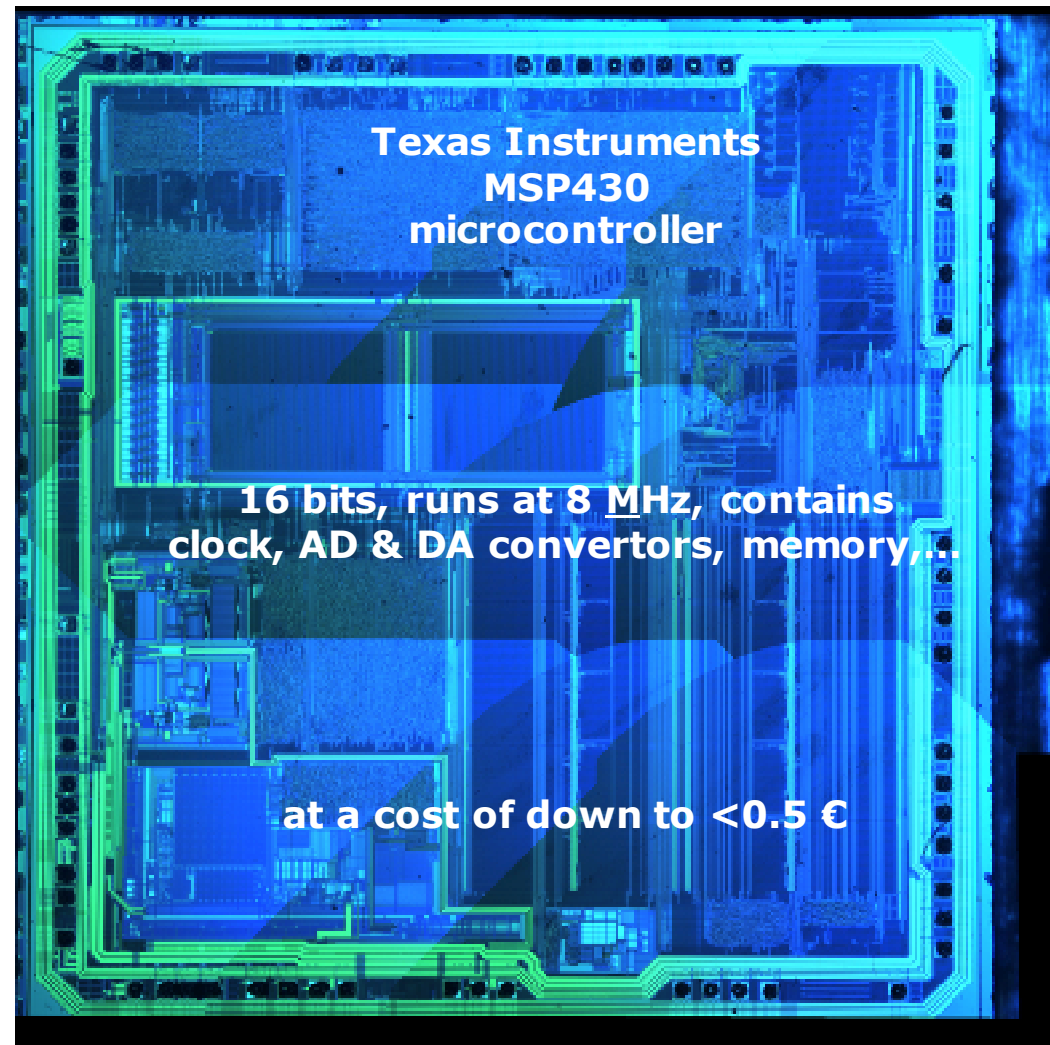
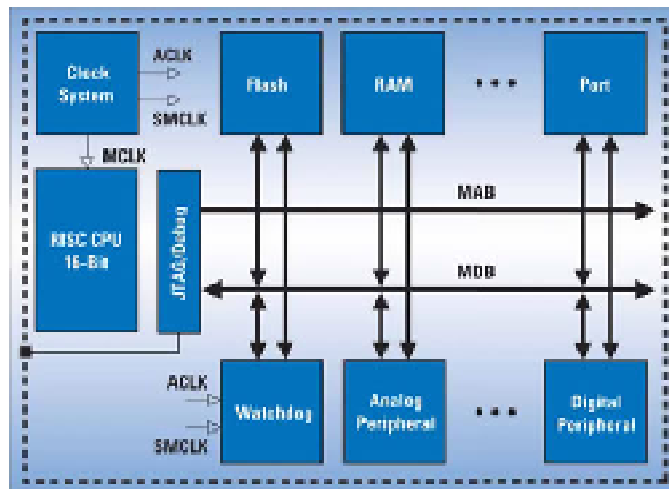
Trends in printed electronics



**World's first organic TFT microcontroller on a foil
(8 bit, 3000 transistors, running at 6 Hz) – ISSCC 2011**

But it will take quite some time until we can print this...

Si IC technology still the most logical way to give the large area flexible electronics product its intelligence



Print where possible, use Si or Cu where needed

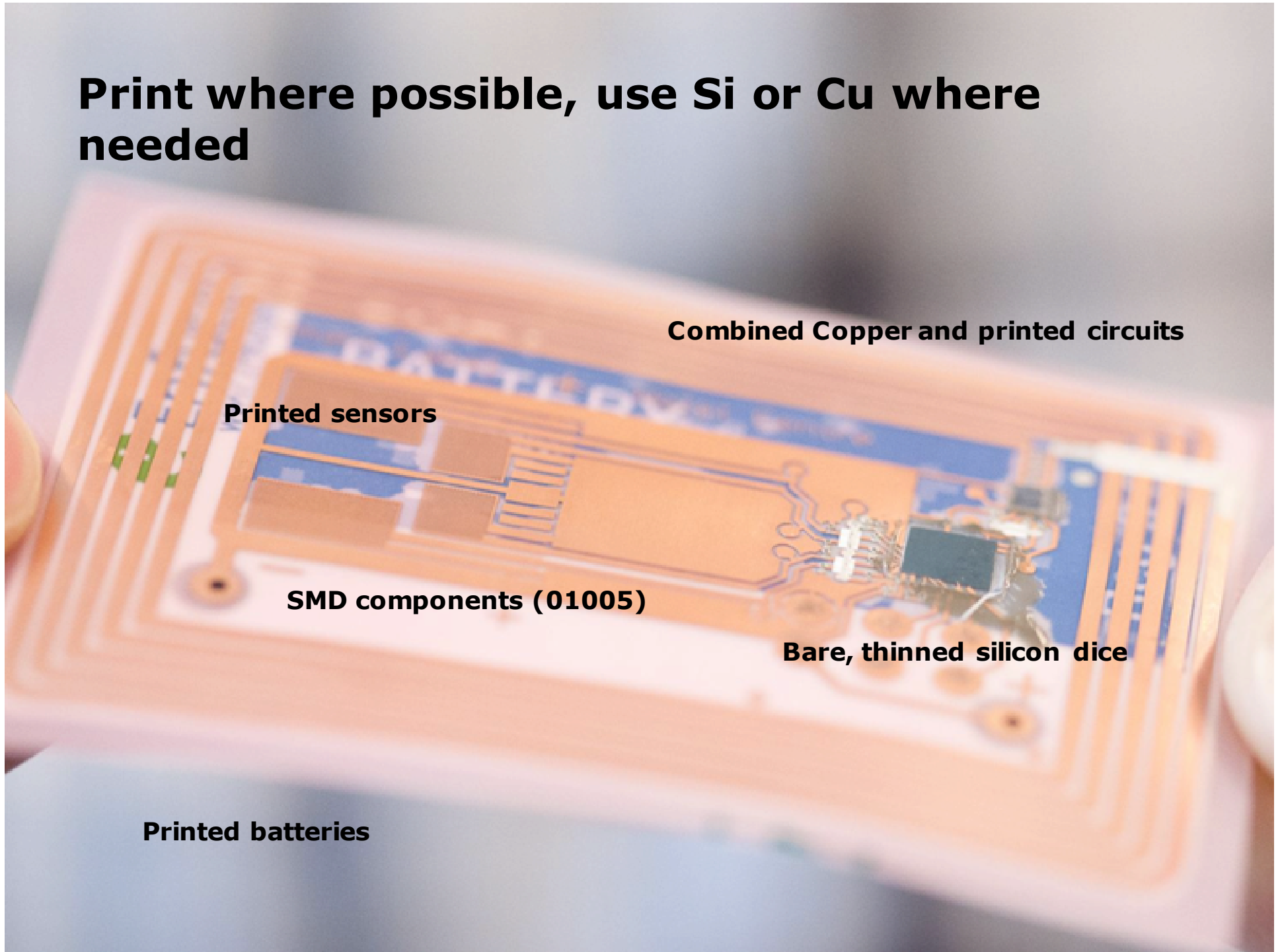
Combined Copper and printed circuits

Printed sensors

SMD components (01005)

Bare, thinned silicon dice

Printed batteries



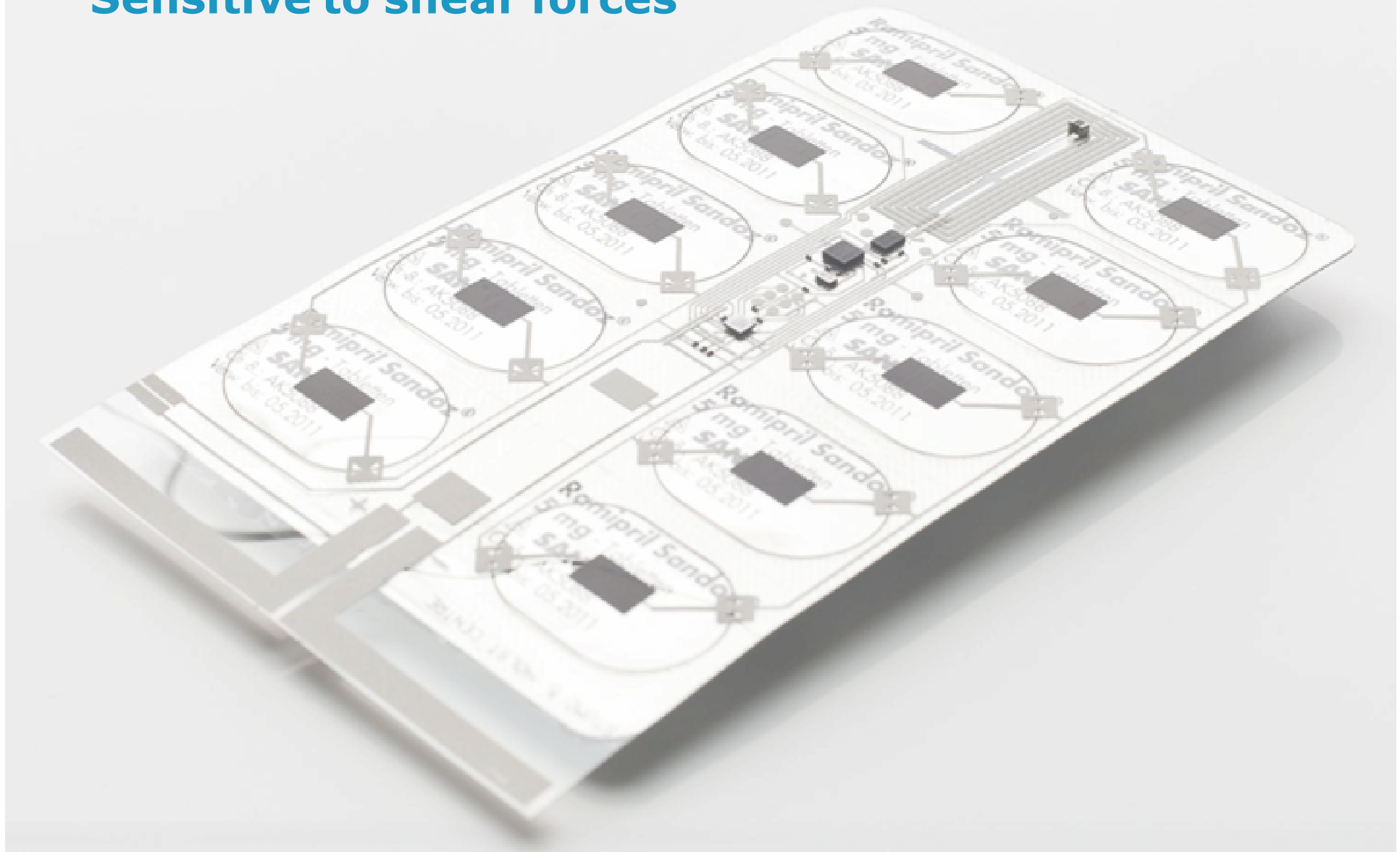
Hybrid electronics for medicine compliance monitoring



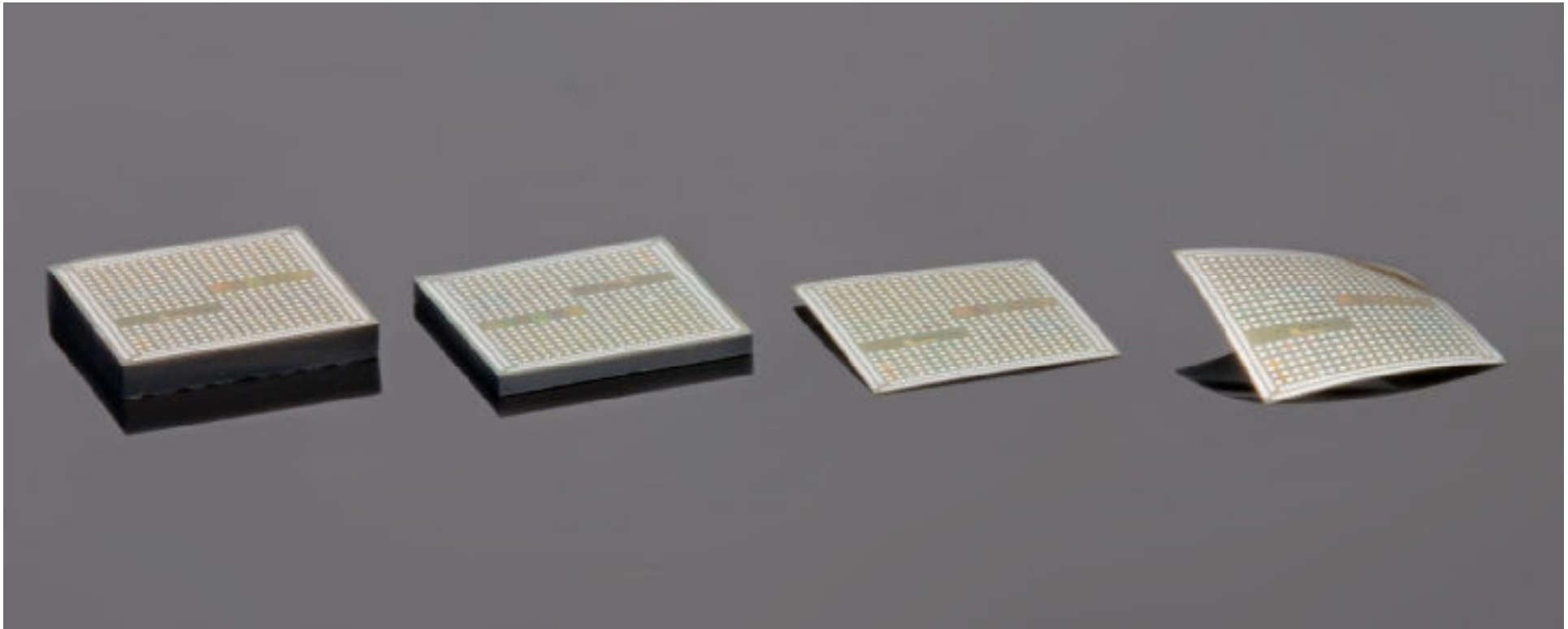
Technology Developments

- **High quality printing**
 - High resolution; Multilayers; Overlay
 - Process control; reproducibility
 - Various substrates
- **Assembly technologies**
 - SMD; Flip chip; Thinned dice; Lamination; Packaging
- **Sensor development**
 - Ultra low power; sensitivity; selectivity
- **System engineering**
 - Design (rules, testing, manufacturing)

Sensitive to shear forces

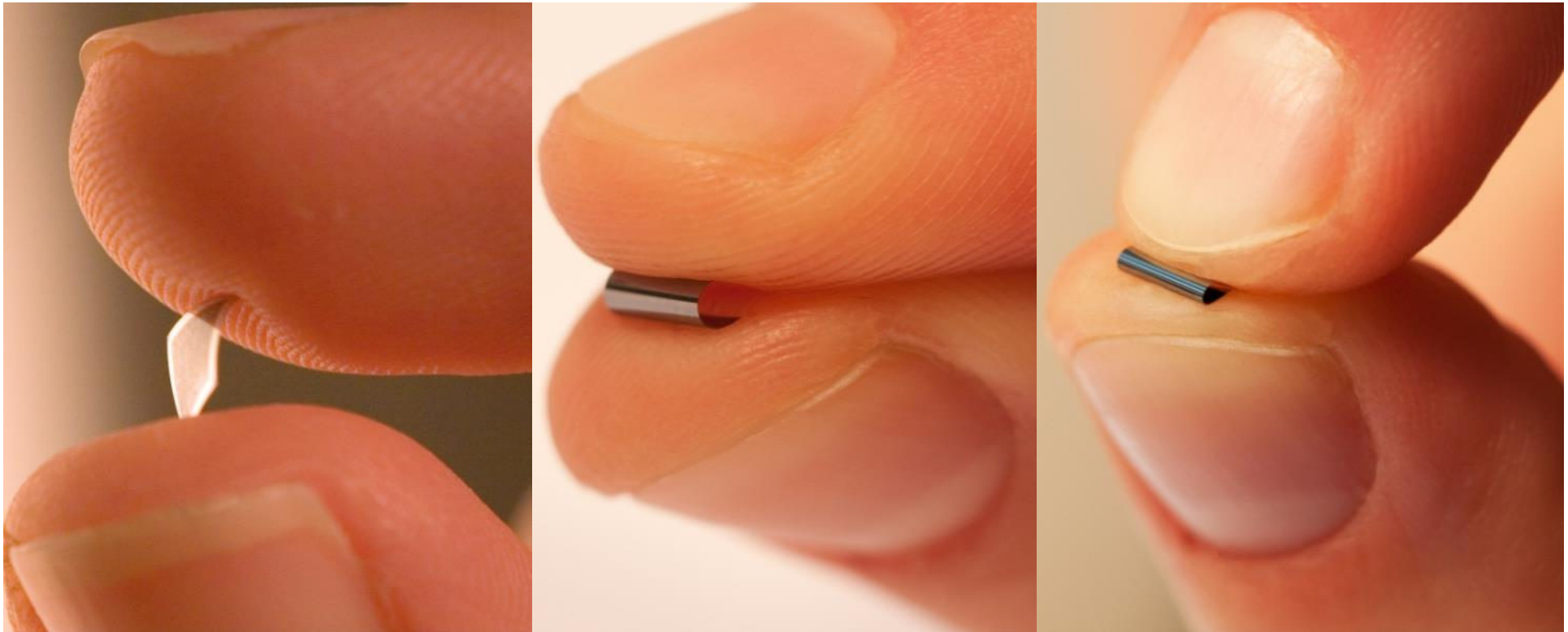


Keeping it thin and flexible



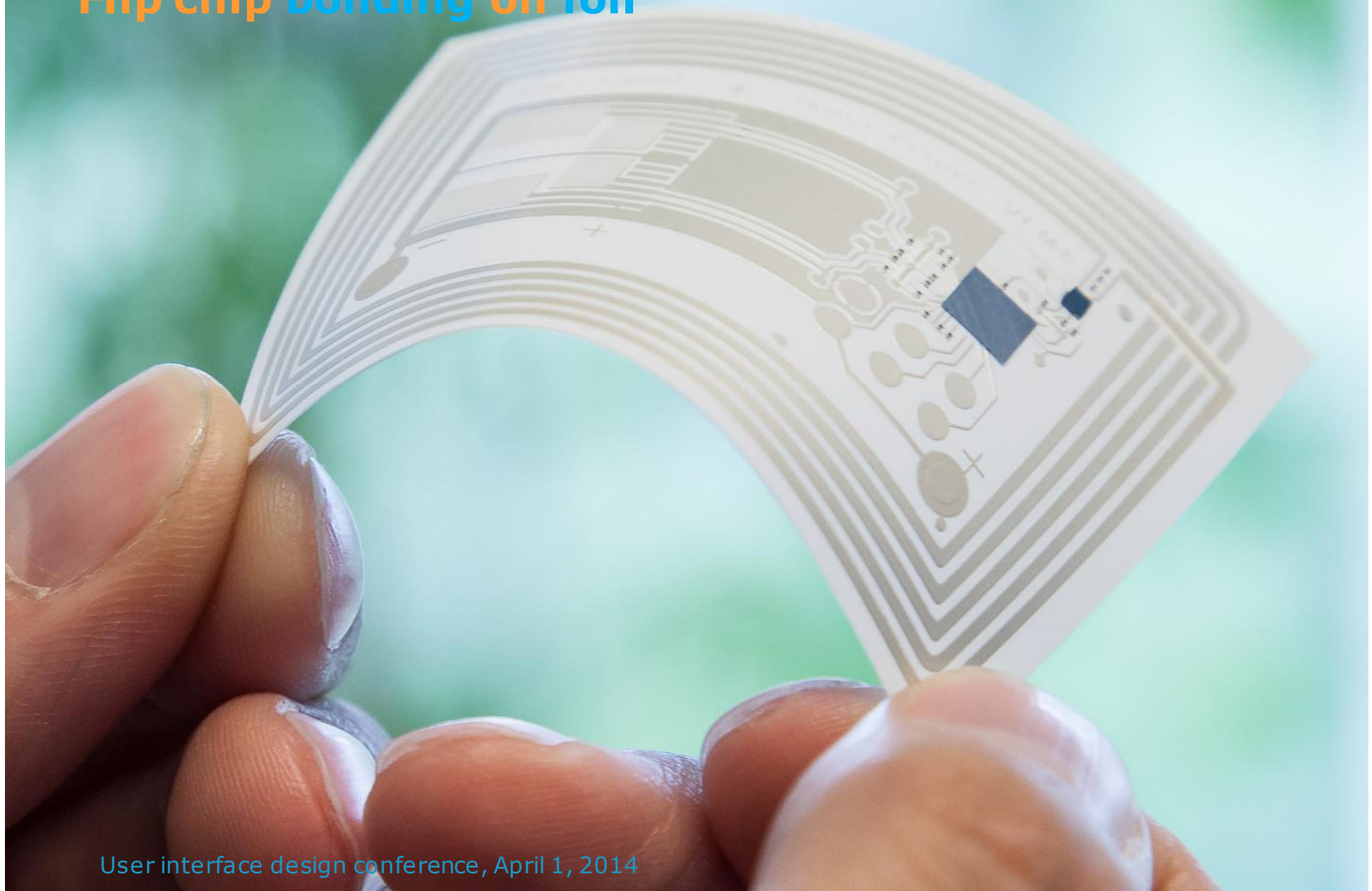
Courtesy IMS-chips

Keeping it **thin** and **flexible**



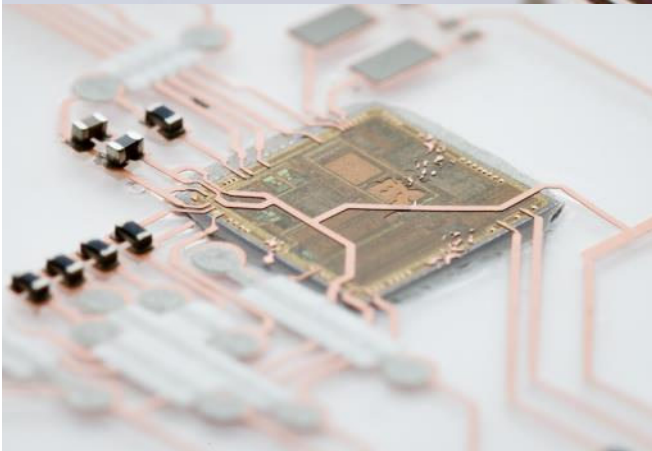
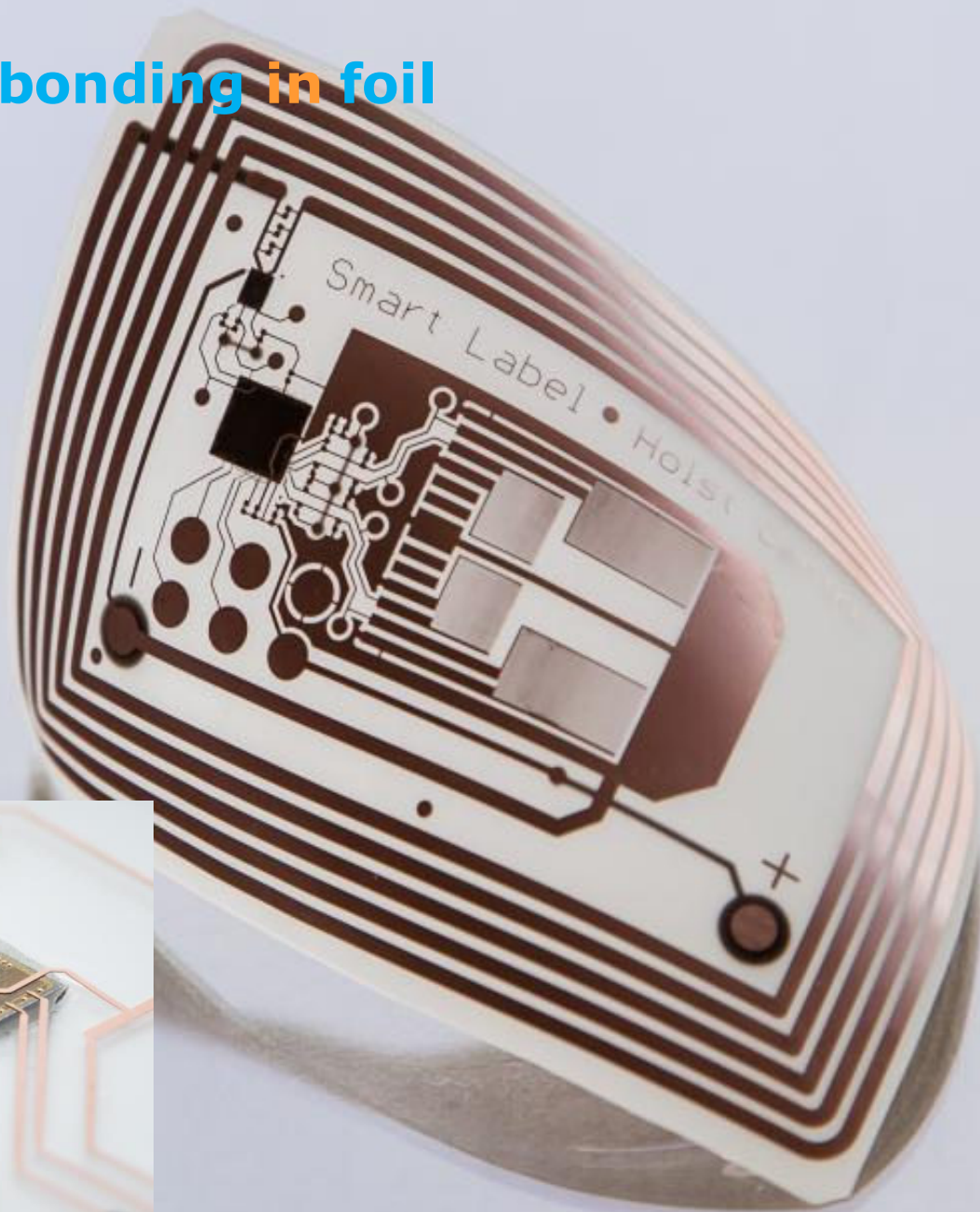
Courtesy IMS-chips

Flip chip bonding on foil



User interface design conference, April 1, 2014

Embedding bonding in foil



Towards simple products



Presentation overview

1. Who we are and what we do
2. First stretch: Thin and flexible smart devices
3. Second stretch: What if flexible is not enough?
4. Third stretch: ...



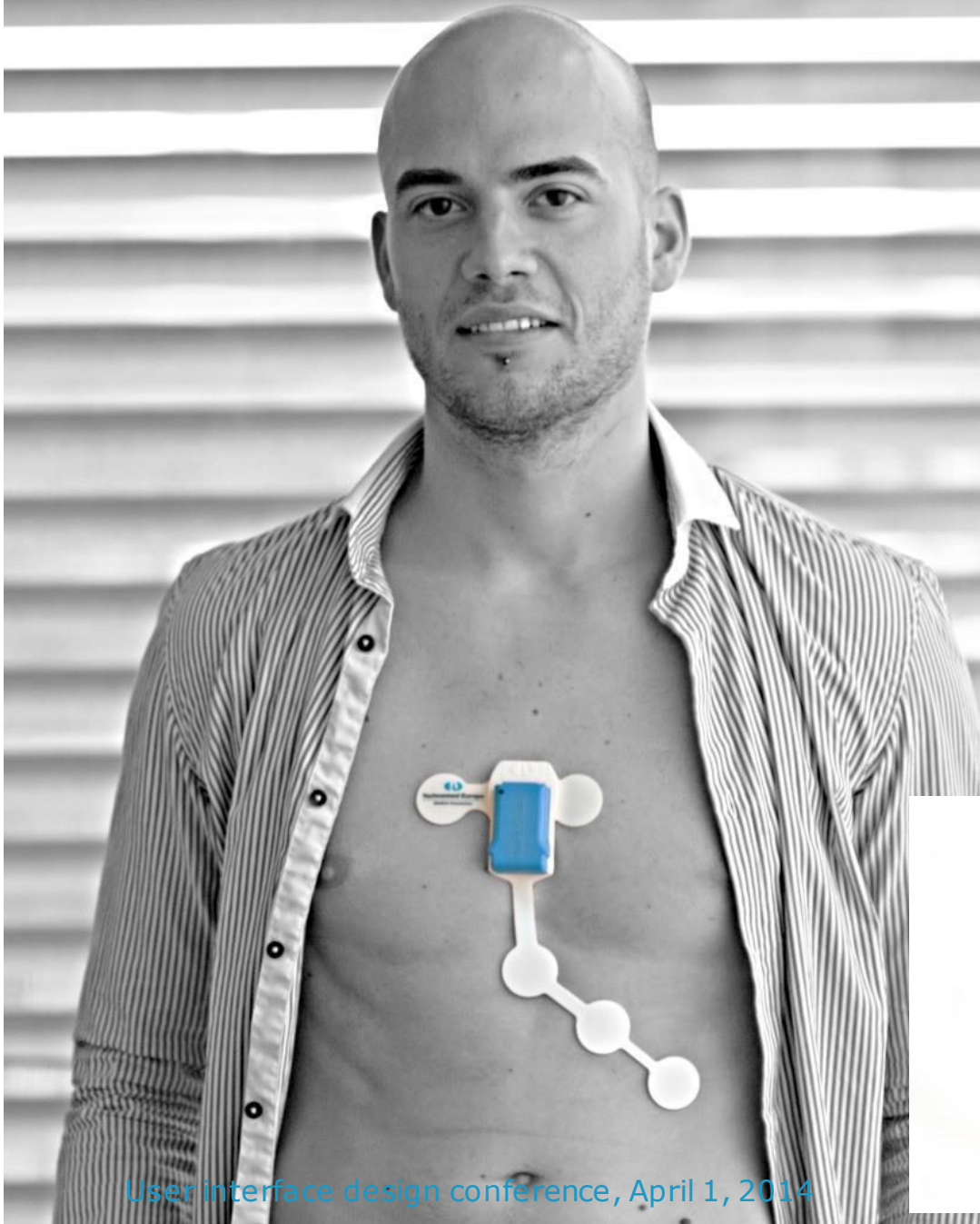
**what if 'flexible'
is not good enough?**



ECG PATCH

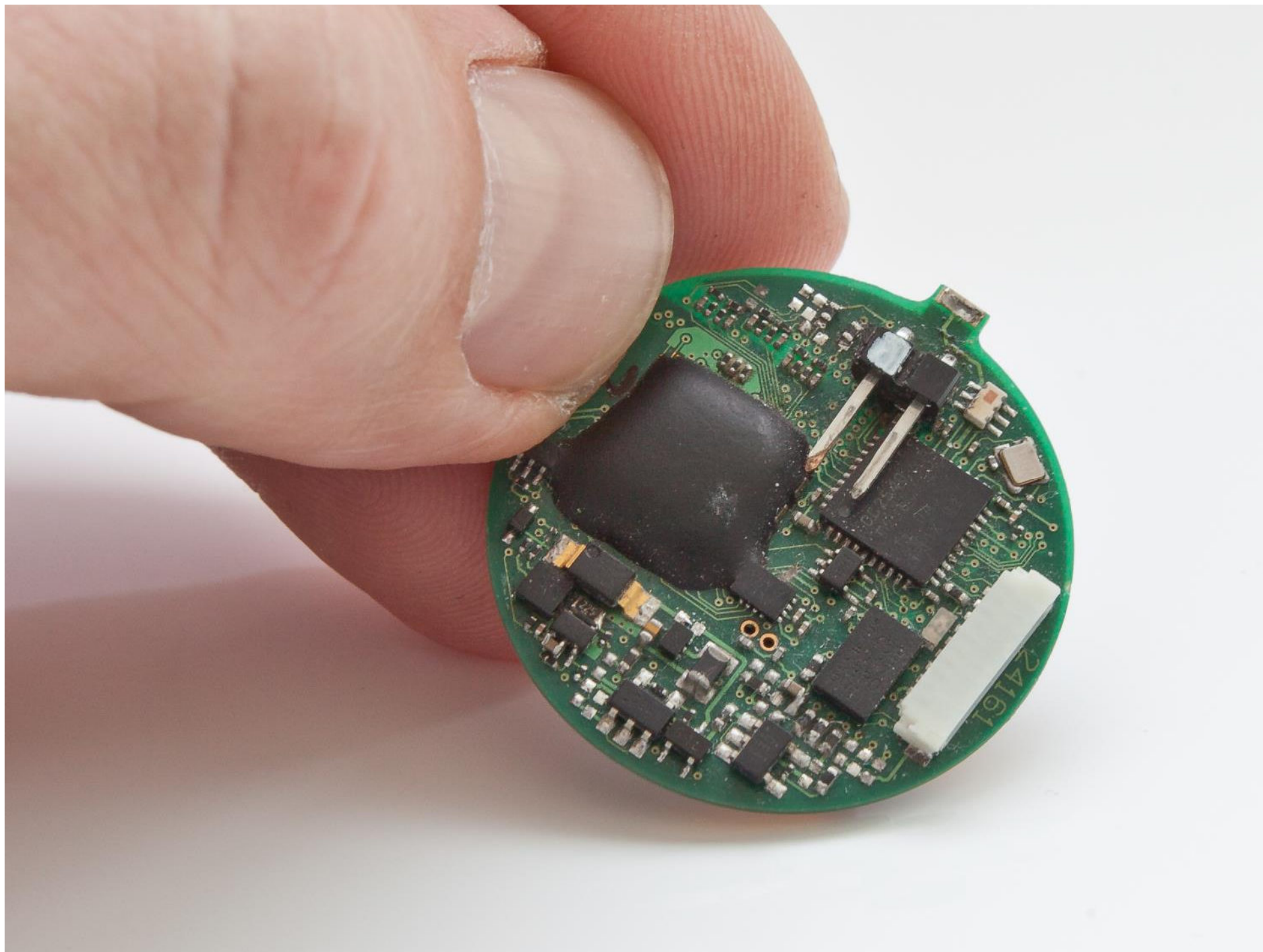
Lowest power, smallest & robust

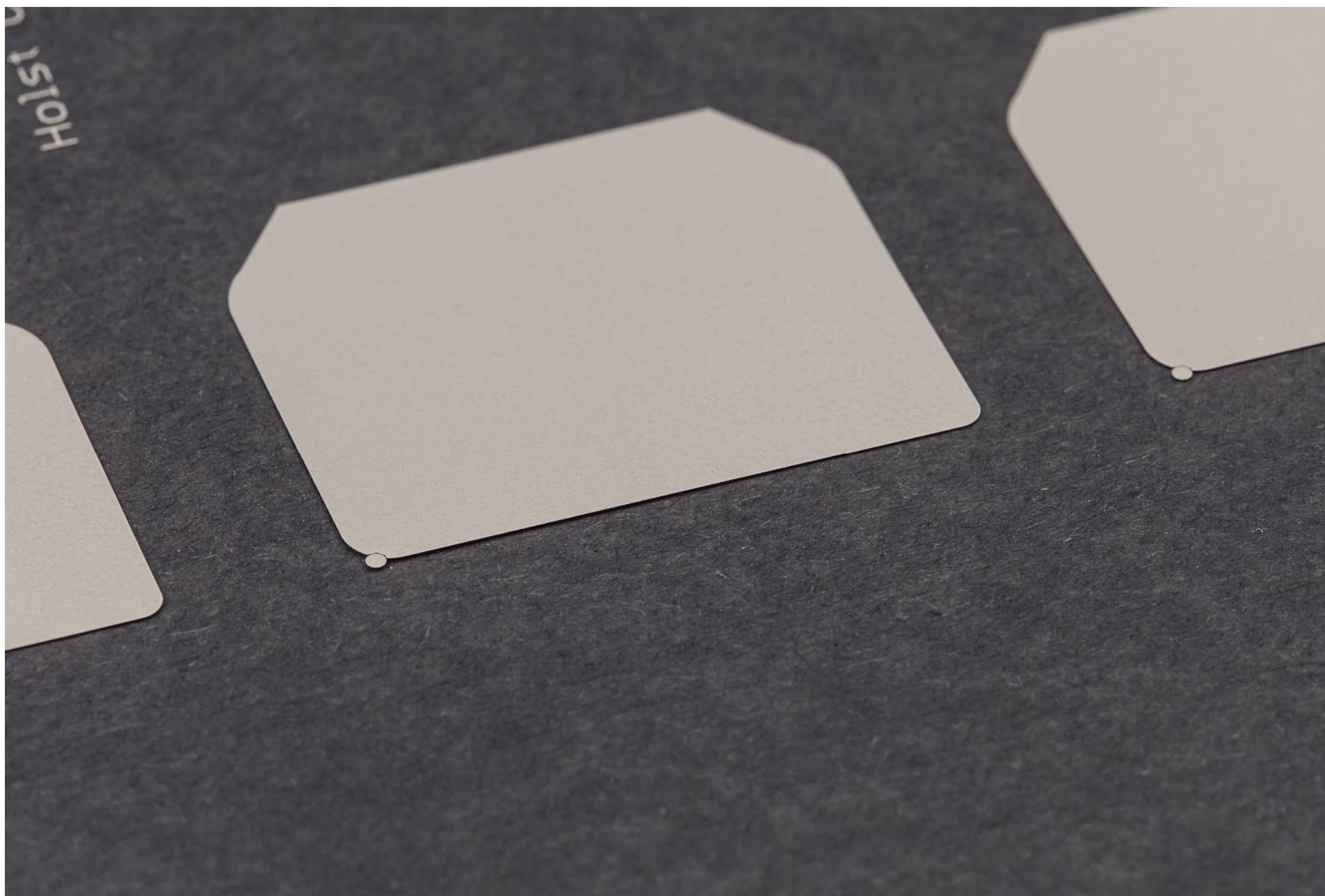
- ▶ Ultra-low power ECG & actimetry measurement
- ▶ Bluetooth low energy
- ▶ Embedded artifact reduction
- ▶ Accurate rhythm analysis
- ▶ Activity tracking & energy expenditure
- ▶ 30 days autonomy

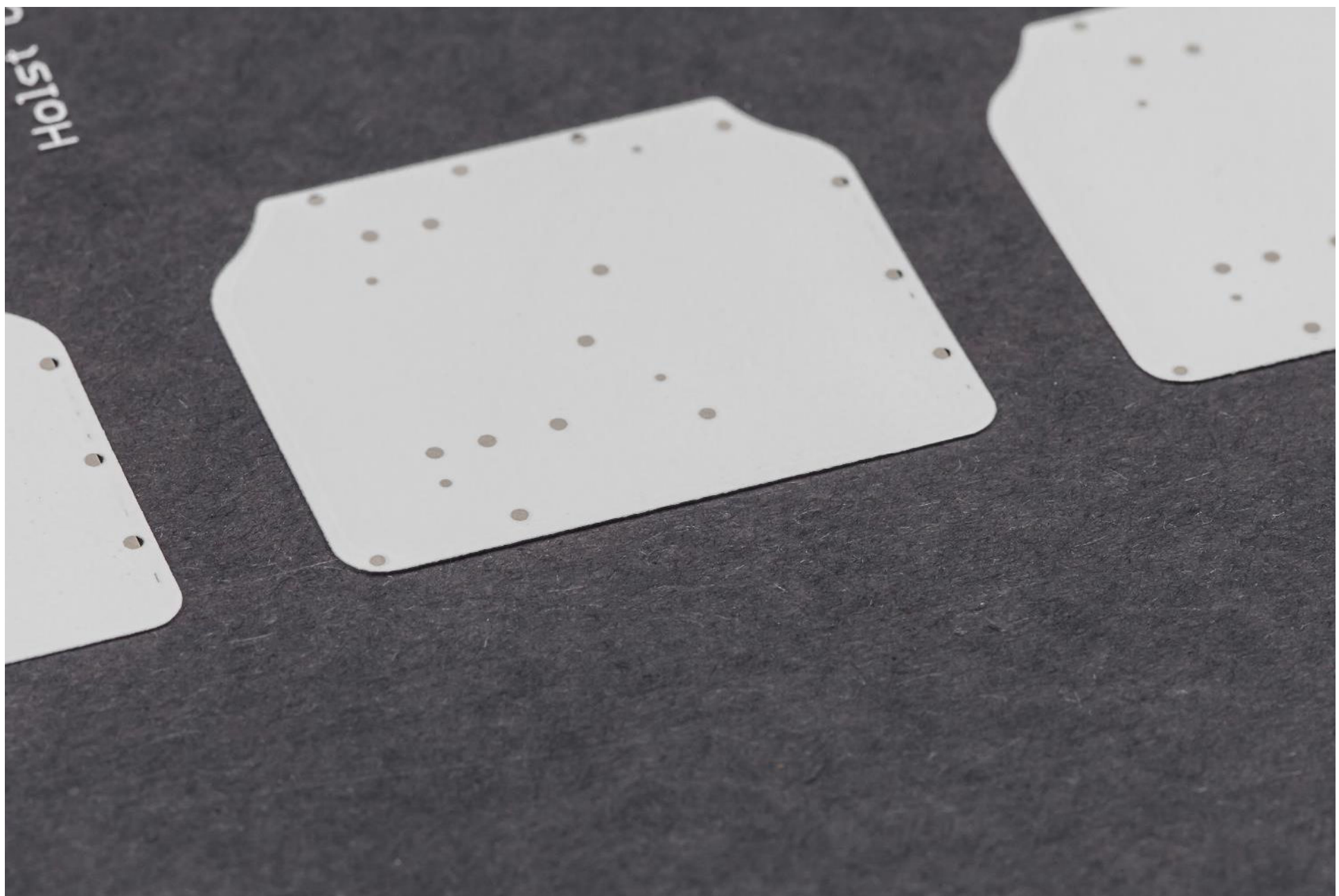


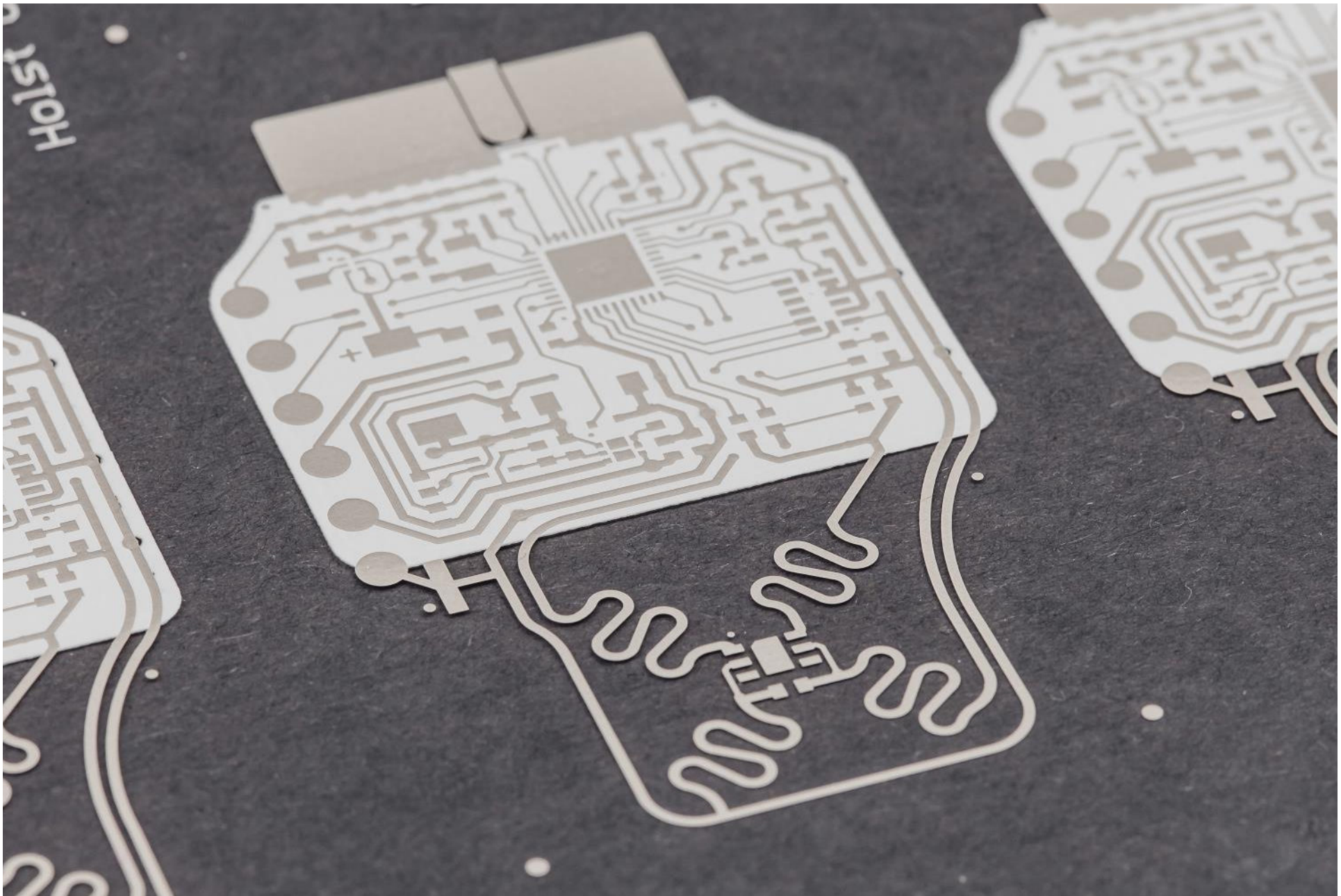


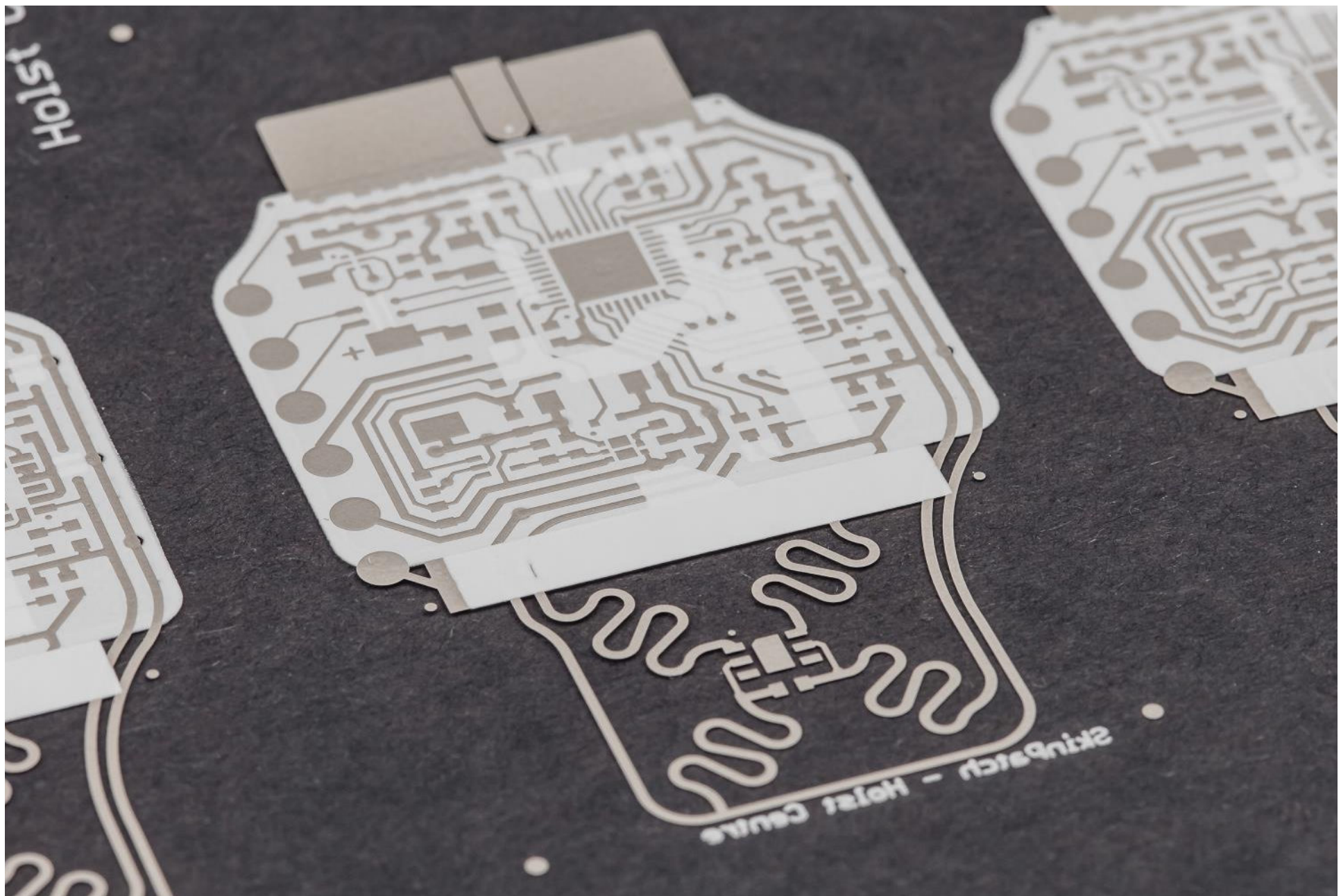
User interface design conference, April 1, 2014

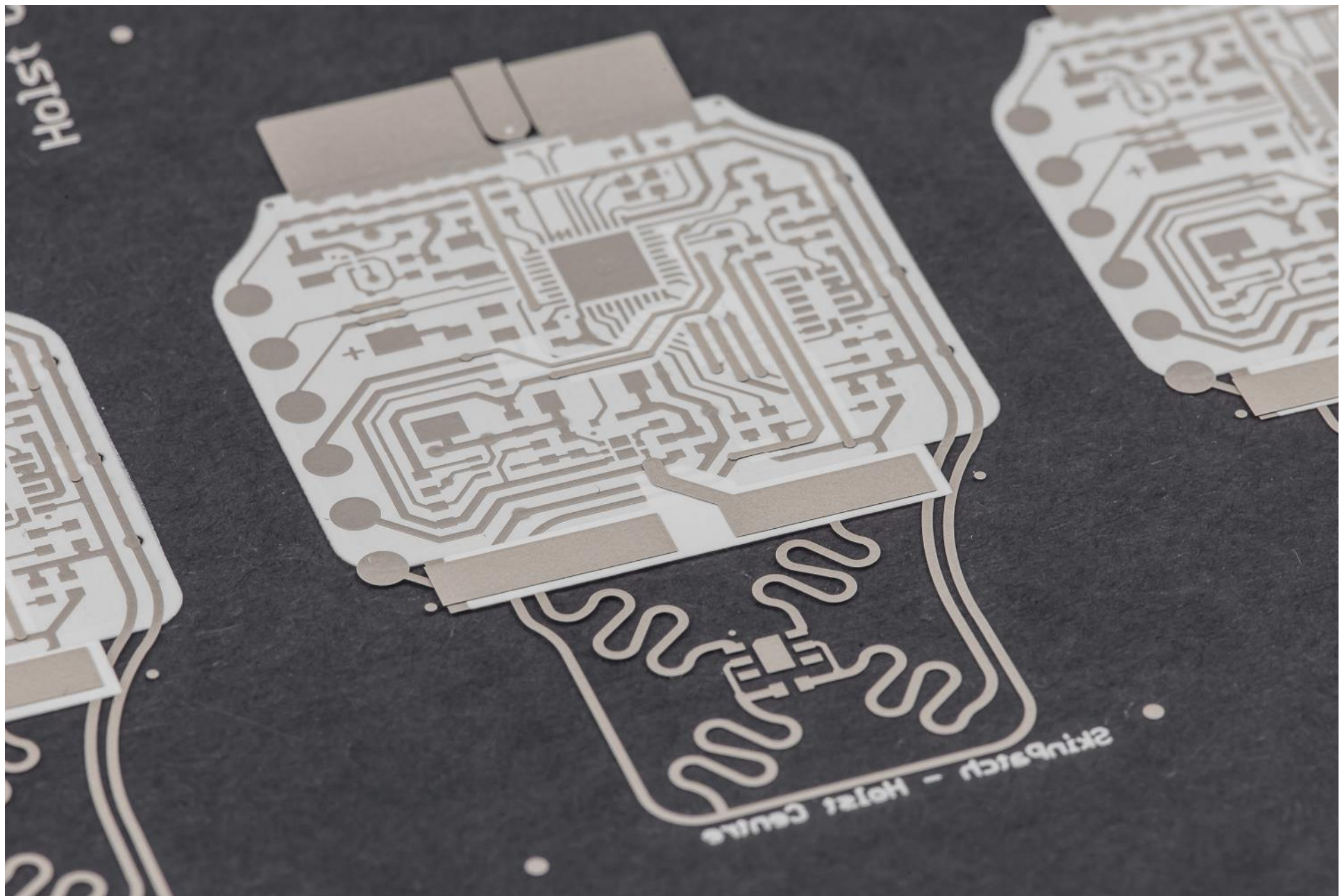


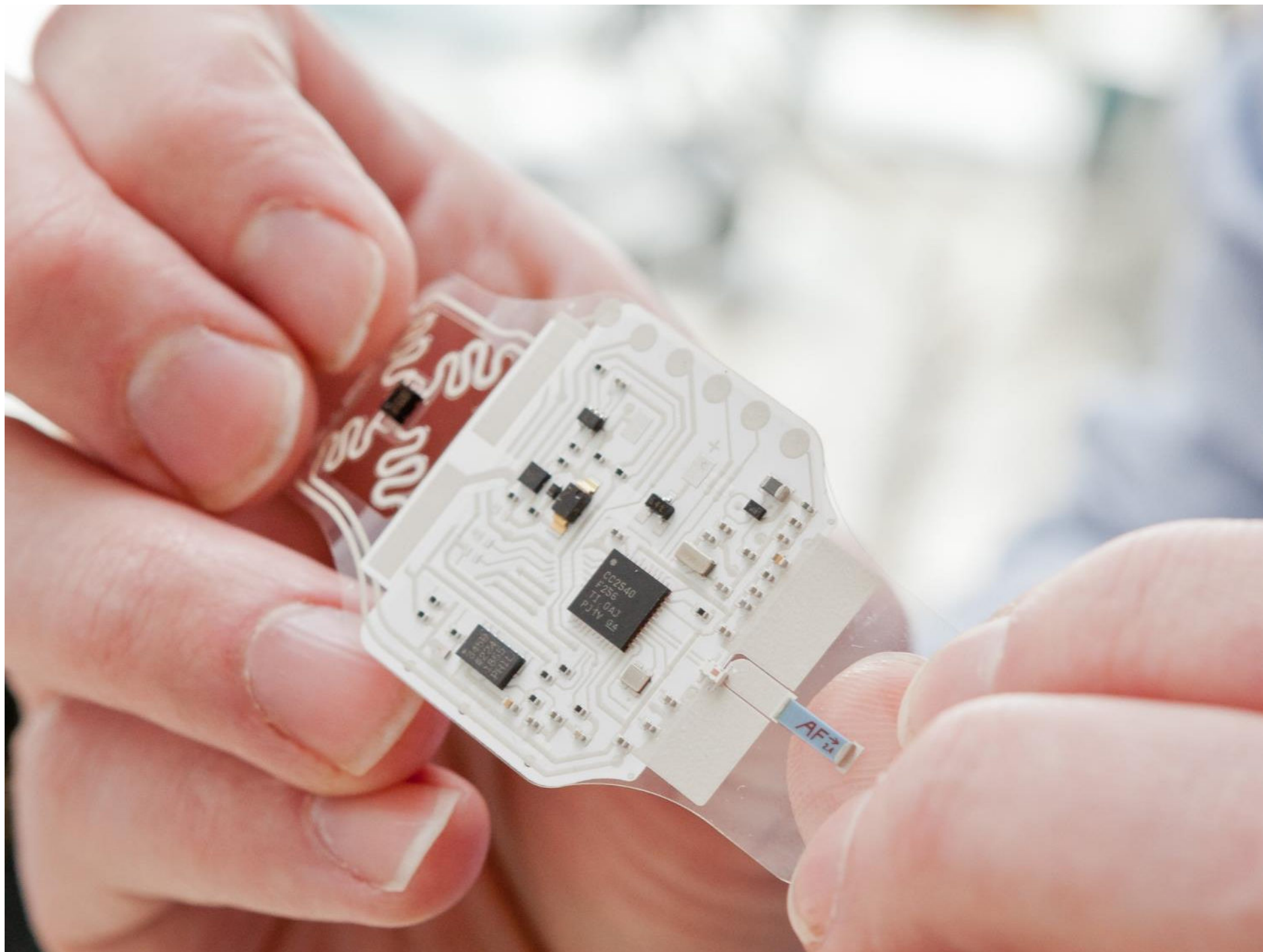


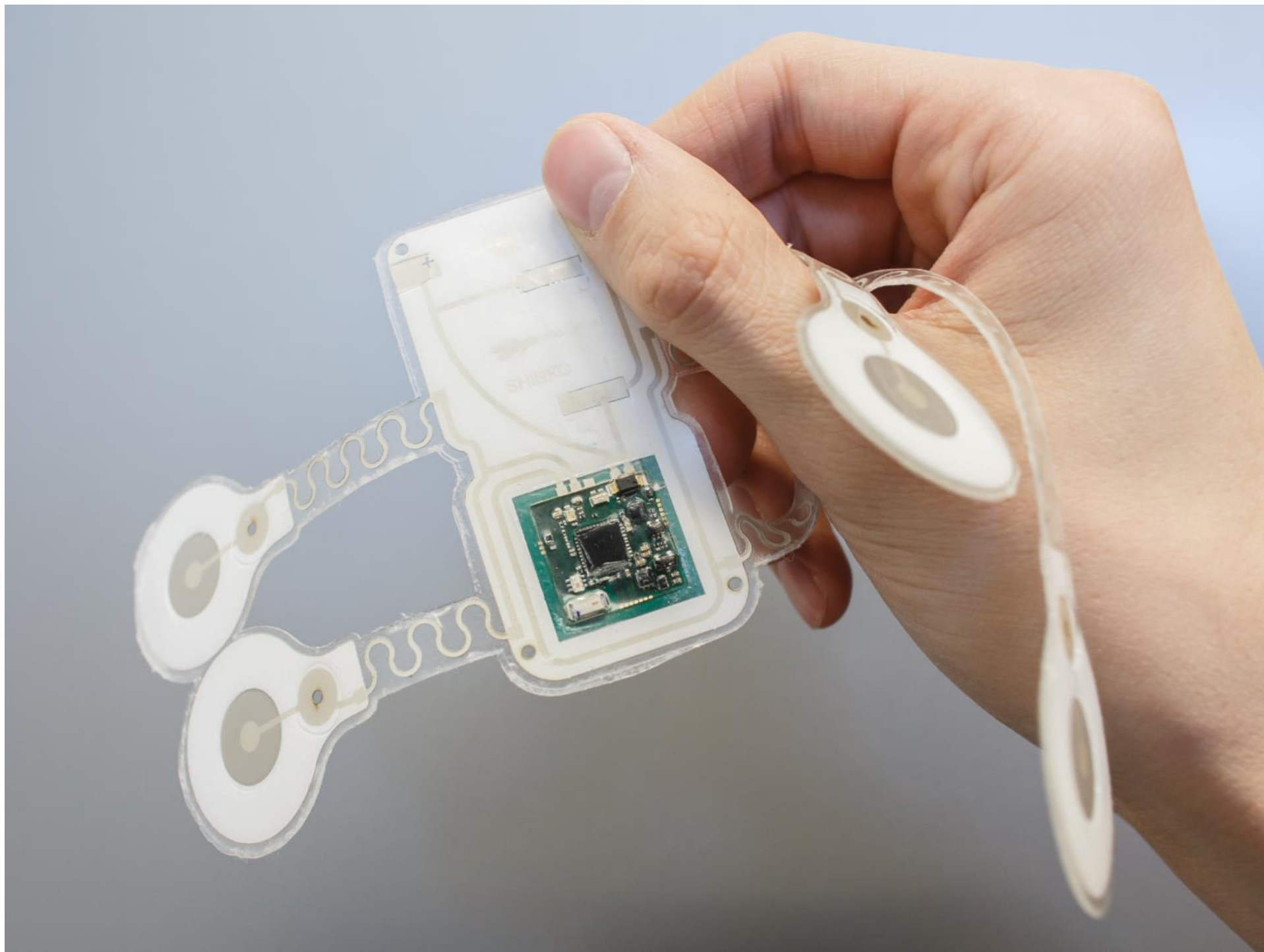


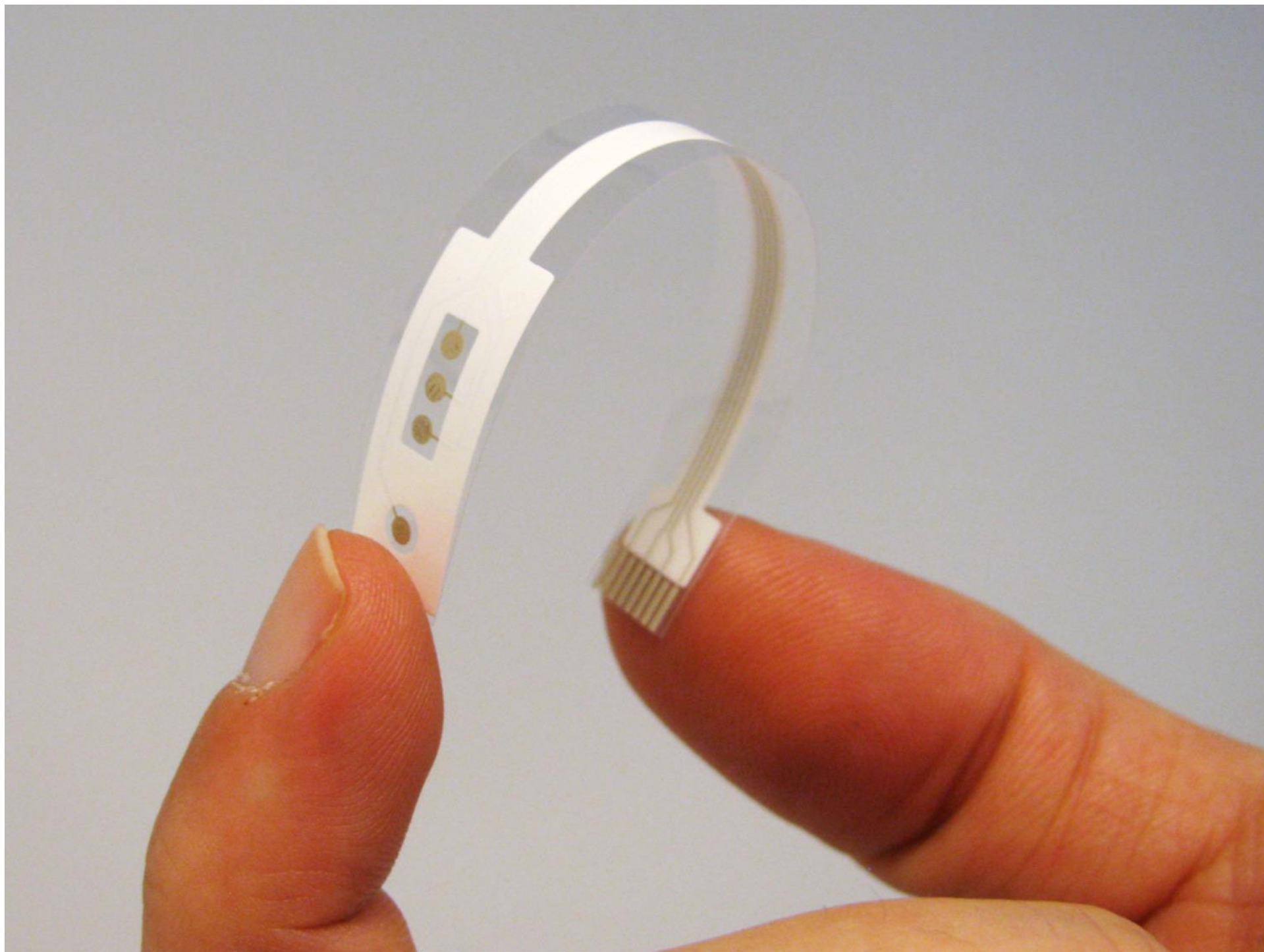




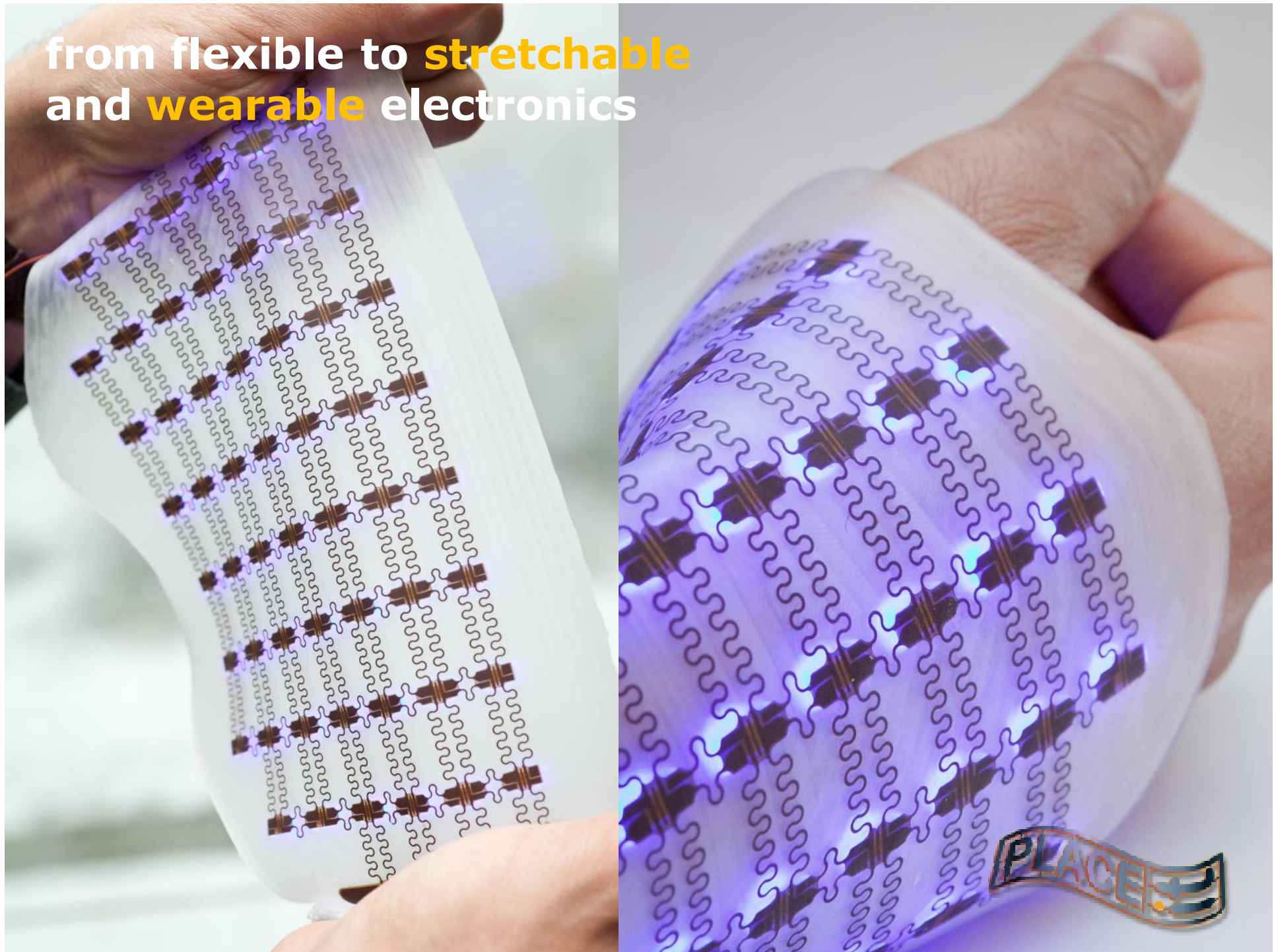








from flexible to **stretchable**
and **wearable** electronics



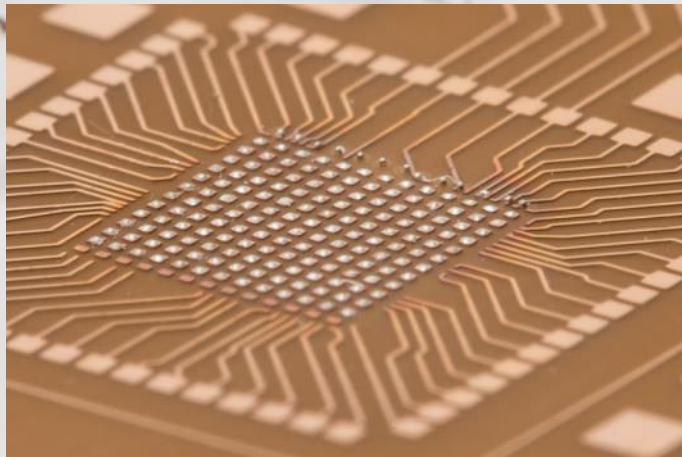
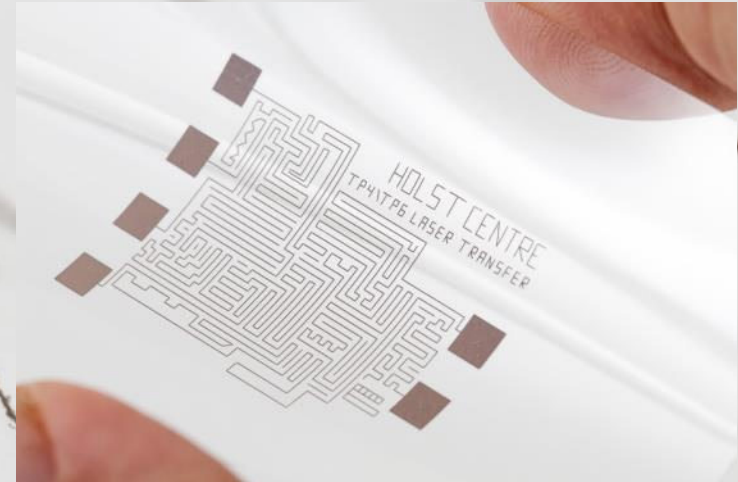
Presentation overview

1. Who we are and what we do
2. First stretch: Thin and flexible smart devices
3. Second stretch: What if flexible is not enough?
4. Third stretch: 3D objects?

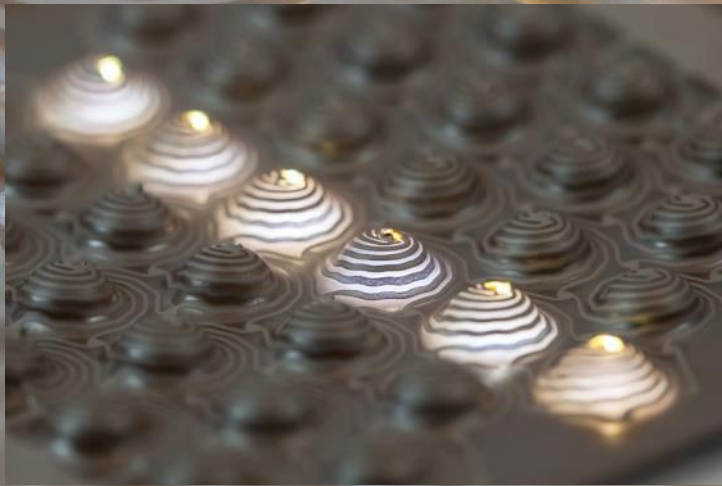


Printing on 3D objects

- **Laser induced forward transfer**

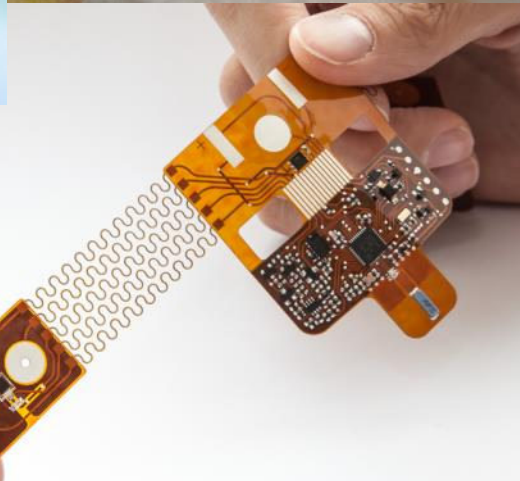
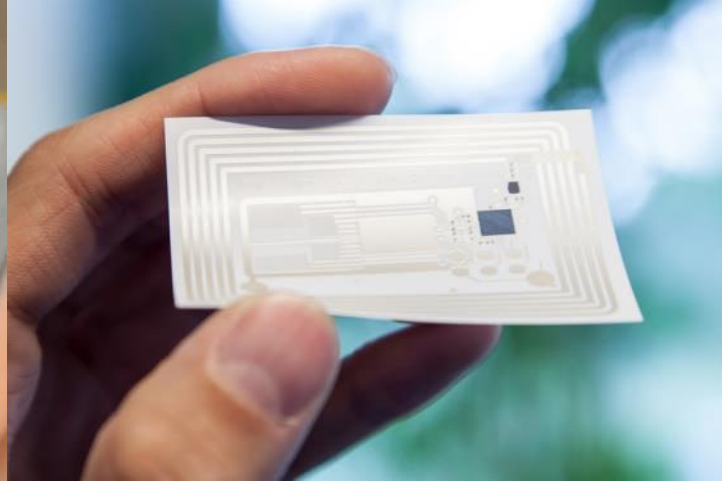


Thermoforming printed and assembled substrates



User interface design conference, April 1, 2014

Stretching the limits of printed electronics



Thank you for your attention!