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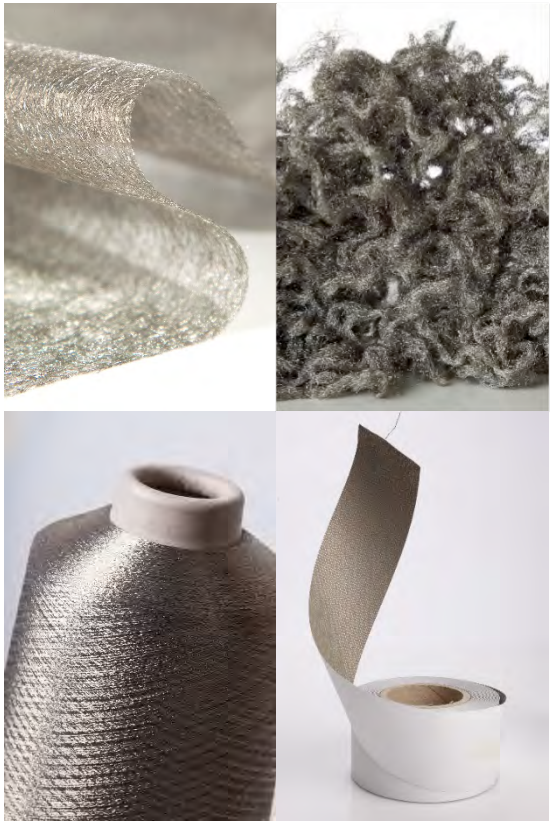
Textile electrodes
- a new paradigm?



1. Introduction: Basic of textile electrodes
2. Different approaches:
   - Conductive fabrics
     - Resistance heating
     - Flexible circuit boards
     - Sensors
     - Patch antennas
     - EMS Electrode
   - Embroidery yarn
     - Technologies
     - Principle of moss embroidery
3. Present application fields
4. Further applications of conductive yarn embroidery

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Properties of silver

- Best electrical conductor of all metals
- Best thermal conductor of all metals
- Antibacterial
- Fungicide
- Odor-inhibiting
- Antistatic
- Kind to the skin
- Electromagnetic shielding
- Anticorrosive
- Low weight
- Ductile

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Advantages of silverized textiles

- Flexible
- Ductile
- High bending and breaking strength
- Textile haptic
- Low weight
- Breathable
- Mechanical stronger than foils
- Great conductivity

Silverized textiles meet the requirements of textile electrodes

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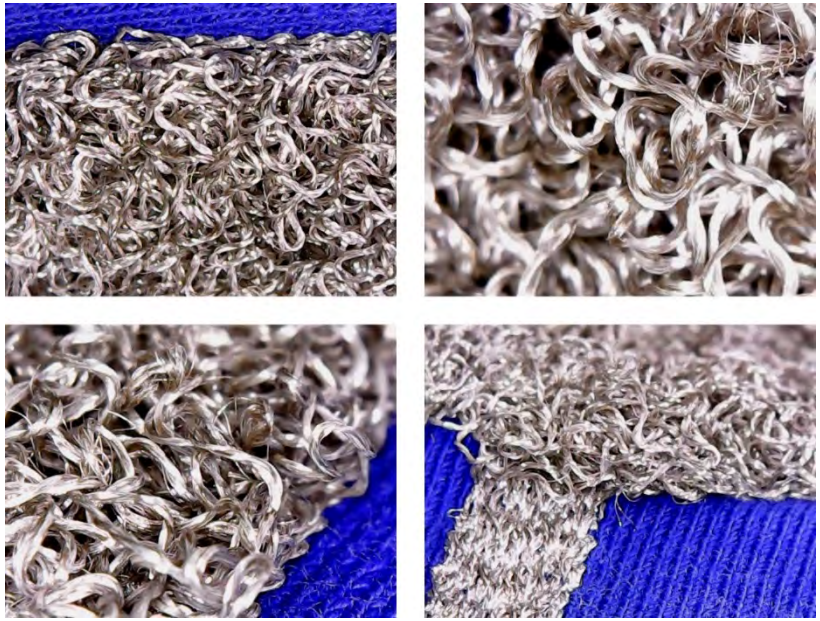
Requirements for textile electrodes

- High usability
- Soft surface of the electrodes
- Highly reproducible
- Washable
- Convenient/ Comfortable
- Biocompatible/ No-skin irritations



Picture Source: M. Hoerr, ZSK Stickmaschinen GmbH, Presentation: „**Technical Embroidery – A Versatile Opportunity for Wearables"** at WTS Conference 2017, London

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Electrodes as…

…Sensors

- Humidity sensor
- Vital parameter monitoring
- Temperature sensor
- Tactile sensors
- Textile switches

…Actuators

- transcutaneous electrical stimulation of nerves - TENS
- Electronic Muscle Stimulation – EMS
- ECG & EMG Sensors

For Shieldex® Smart textiles recommendations, please get in touch with us! We are please to support you with our Know-How!

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Textile Electrodes

Conductive Fabric

Embroidery yarn

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Shieldex® Zell RS

Description:	Tin / copper / silver plated polyamide ripstop fabric
Surface resistivity:	< 0.02 Ohms/□
Total thickness:	0.110mm ± 15%
Weight:	77g/m² ± 15%
Roll width:	130cm ± 4cm
Roll length:	200m ± 10m

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Applications

- **Sensors**
  - Medical Sensors
  - Electrodes
  - Capacitive Sensors
  - Switches
  - Pressure Sensors
  - Smart Wear Sensors

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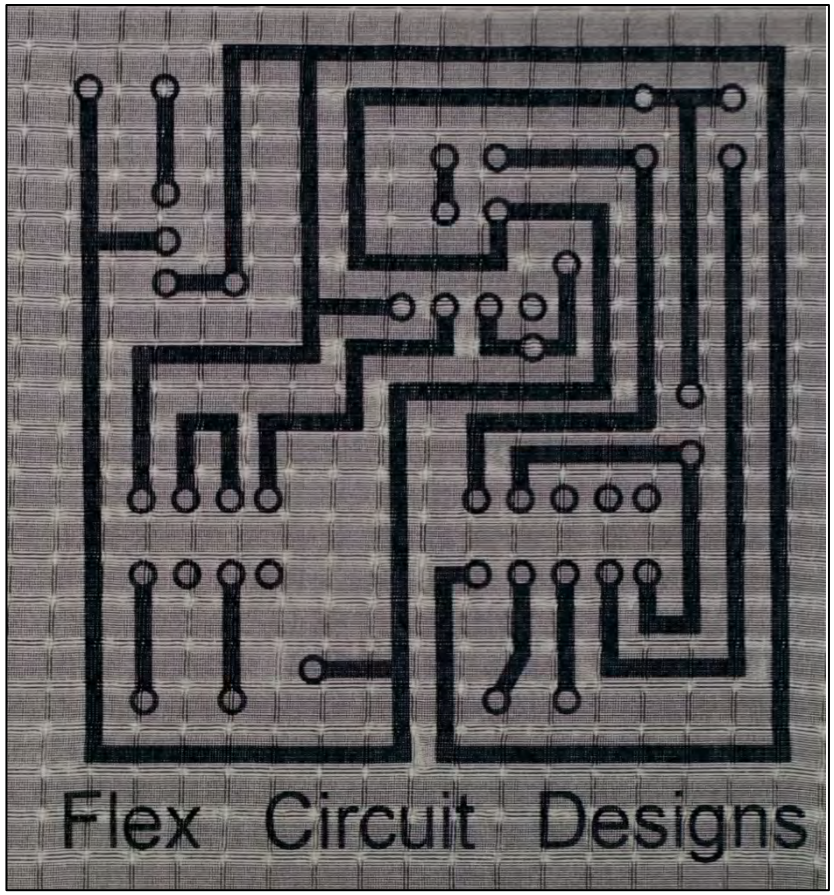
Applications

- **Flexible Circuit Boards**
  - Smart Wear Applications
  - Soft and flexible electronic applications
  - Bus lane Systems



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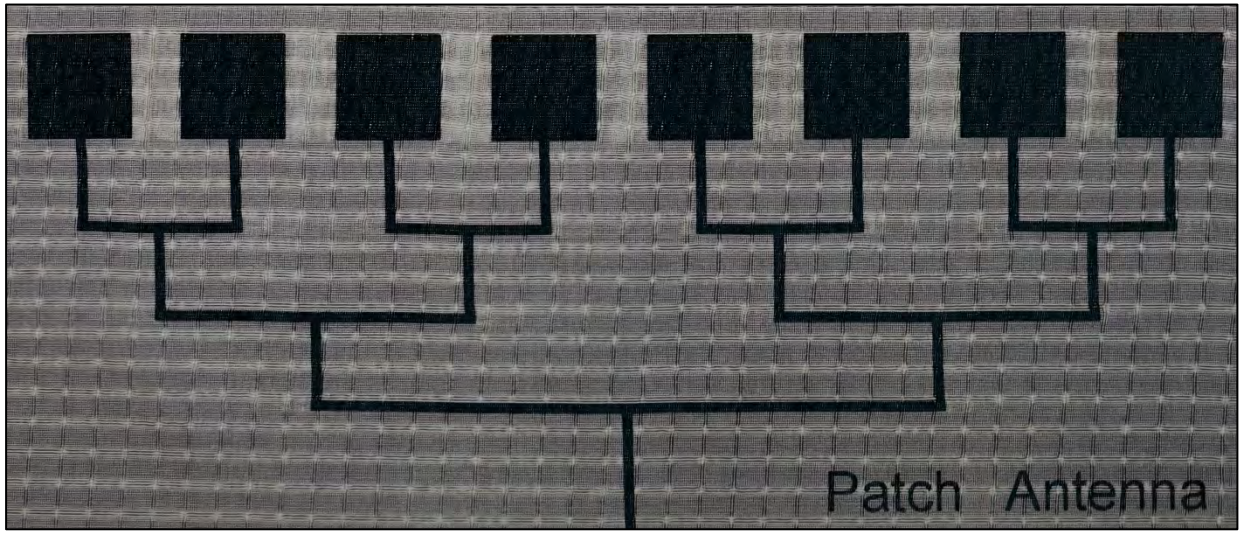
Applications



Patch Antennas

- Wireless communication applications
- Aerospace
- Military
- Smart Wear

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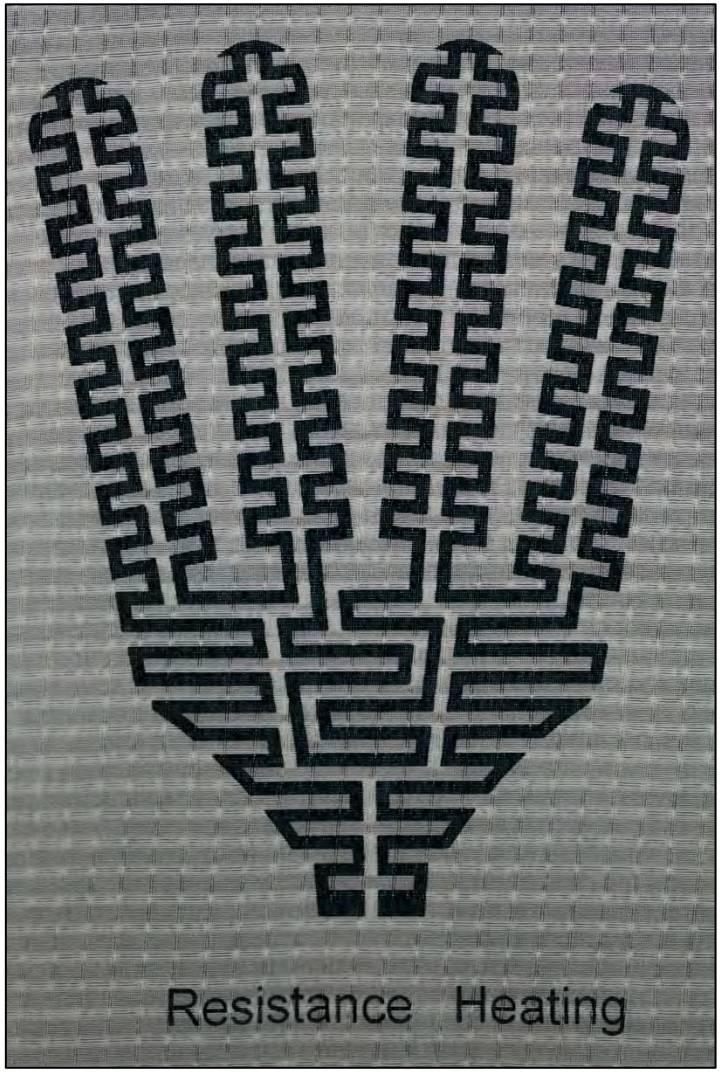
Applications

- **Resistive Heating**
  - Clothing
  - Gloves
  - Curtains
  - Flooring
  - Automotive
  - Aerospace



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Shieldex® Silitex P130

Description:	Silicone coated conductive **stretchable** fabric
Surface resistivity:	< 10 Ohms/□
Total thickness:	0,65mm ± 10%
Weight:	380g/m² ± 10%
Roll width:	121cm +3/-6
Roll length:	max. 38m

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Silicone coated conductive fabric

Picture Source: Wearable Life Science GmbH – Antelope Suit

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Embroidery yarn

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Embroidery yarn

Madeira HC 40 (< 300 Ω/m) / **Madeira HC 12** (< 100 Ω/m)

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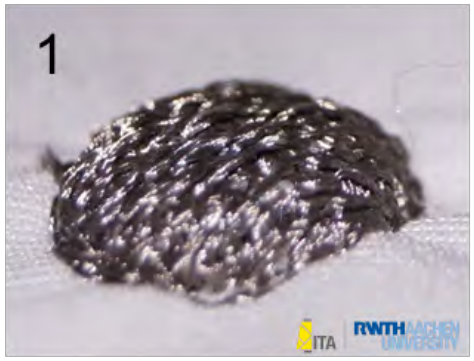
Embroidery yarn

Technology for textile electrodes:

- weaving
- Warp-Knitting
- knitting
- Embroidery



Variation of embroidered electrodes:
1: embroidered 3D-Elektrode;
2: Moss embroidered electrode;
3: Embroidered flat 4-Layer electrode

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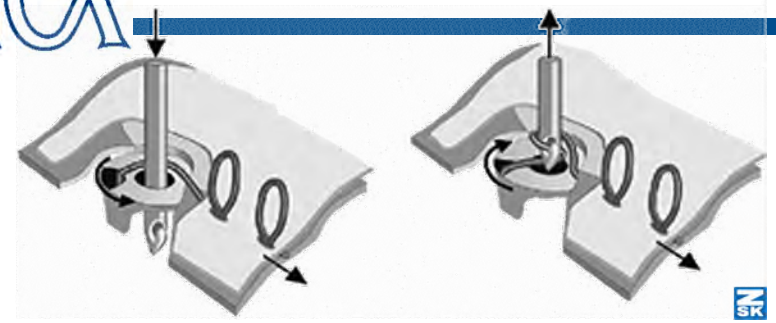
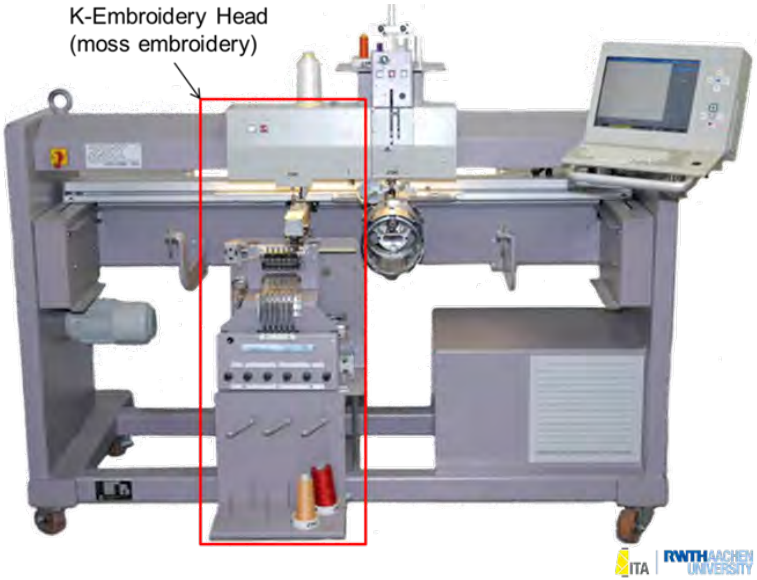
Principle of Moss Embroidery

- One-thread system
- Needle goes through the carrier material and pulls the thread out from under the needle
- Loop is created by a rotary motion of the needle on the upper side of the carrier material
- Repeating this pattern frequently produces a moss-like surface



Principle of Moss Embroidery



Embroidery machine JCL 0100-585 with K-Head for moss embroidery of ZSK Stickmaschinen GmbH, Krefeld, Germany

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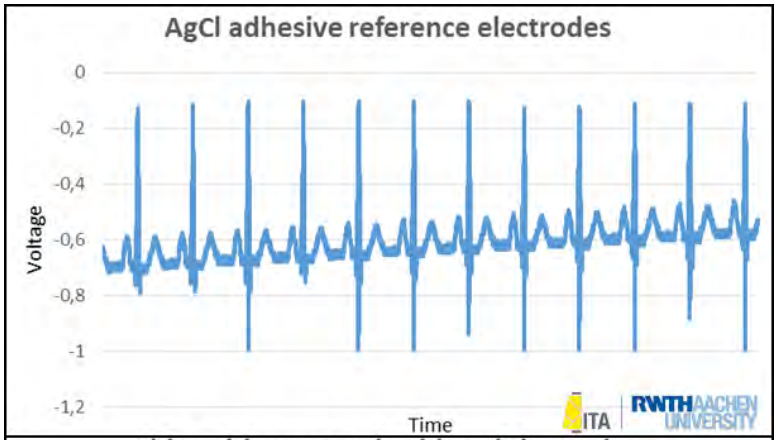
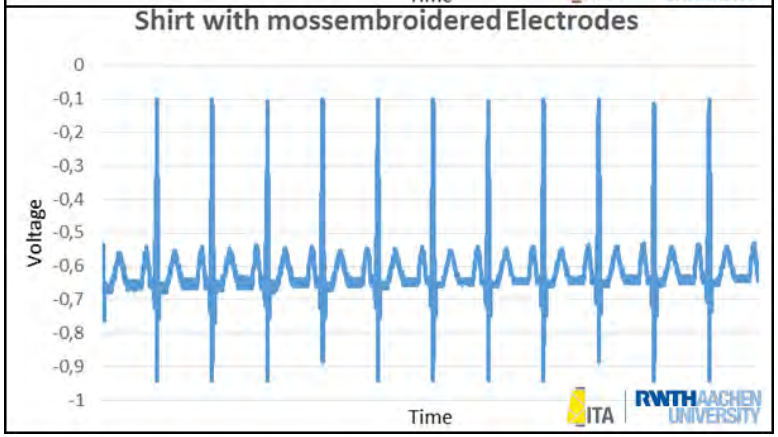
AgCL vs. Moss Embroidered Electrodes

Measurement of ECG:





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Application Summary:

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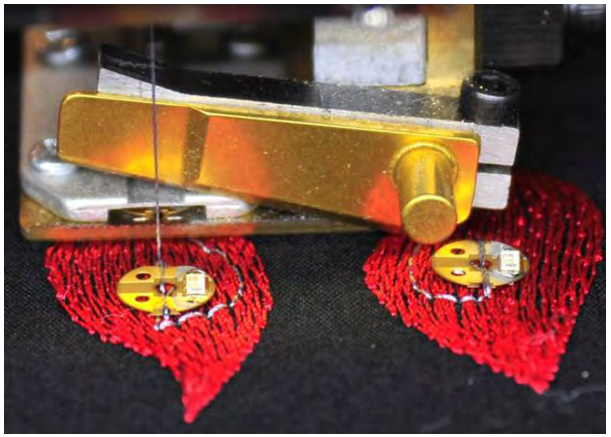
Further applications of conductive yarn embroidery



Integration of 14 LED sequins in a sweater

Picture Source: M. Hoerr, ZSK Stickmaschinen GmbH, Presentation: „**Technical Embroidery – A Versatile Opportunity for Wearables”** at WTS Conference 2017, London

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Electronic integration

Picture Source: M. Hoerr, ZSK Stickmaschinen GmbH, Presentation: „**Technical Embroidery – A Versatile Opportunity for Wearables”** at WTS Conference 2017, London

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Application example of embroidered piano

Source: M. Hoerr, ZSK Stickmaschinen GmbH, PromoTex Expo “Forum 13”, 2019 Düsseldorf, Präsentation:
„Wenn das Kopfkissen Musik macht und das Sweatshirt leuchtet: Die Möglichkeiten der technischen Stickerei zur Produktion smarter Textilien”

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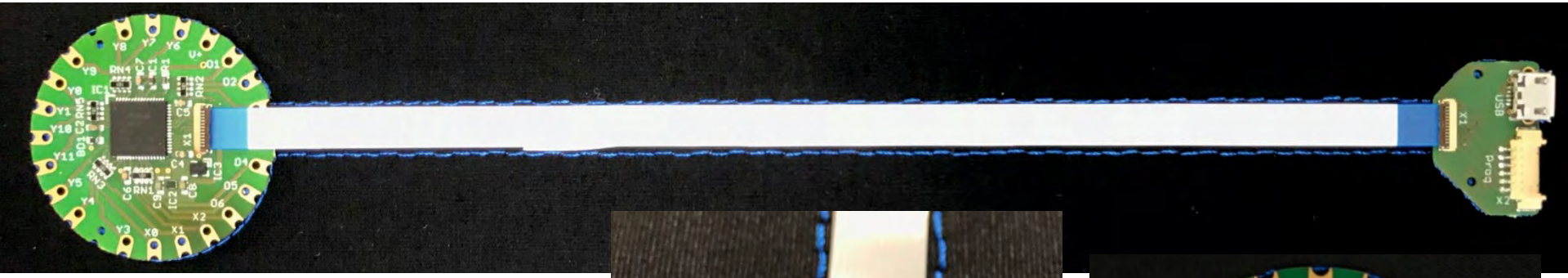
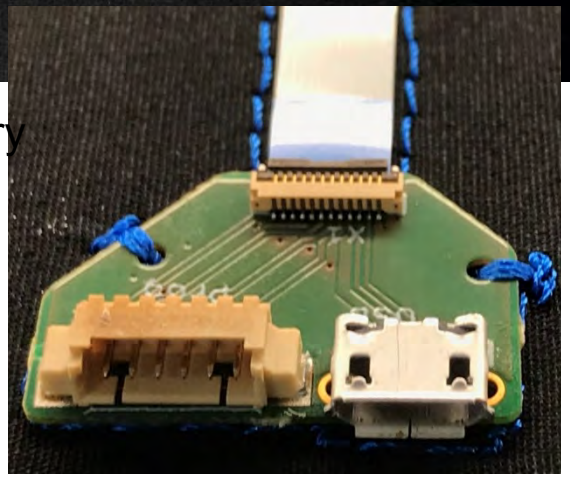
ZSK-E-Tex-Board





- Especially designed for embroidery
- 21 electronic (GPIO) pins
- Controls up to
  - 19 LEDs with 1 sensor or
  - 7 LEDs with 13 sensors and
  - any combination between
- 1 Pin V+
- Ø 40 mm and 2 mm thickness
- Power supply (Mini USB) and programmer port on a separate embroiderable board

Source: M. Hoerr, ZSK Stickmaschinen GmbH, PromoTex Expo “Forum 13”, 2019 Düsseldorf, Präsentation:
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Dash Board with ZSK-E-Tex-Board and LEDs integrated by embroidery

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