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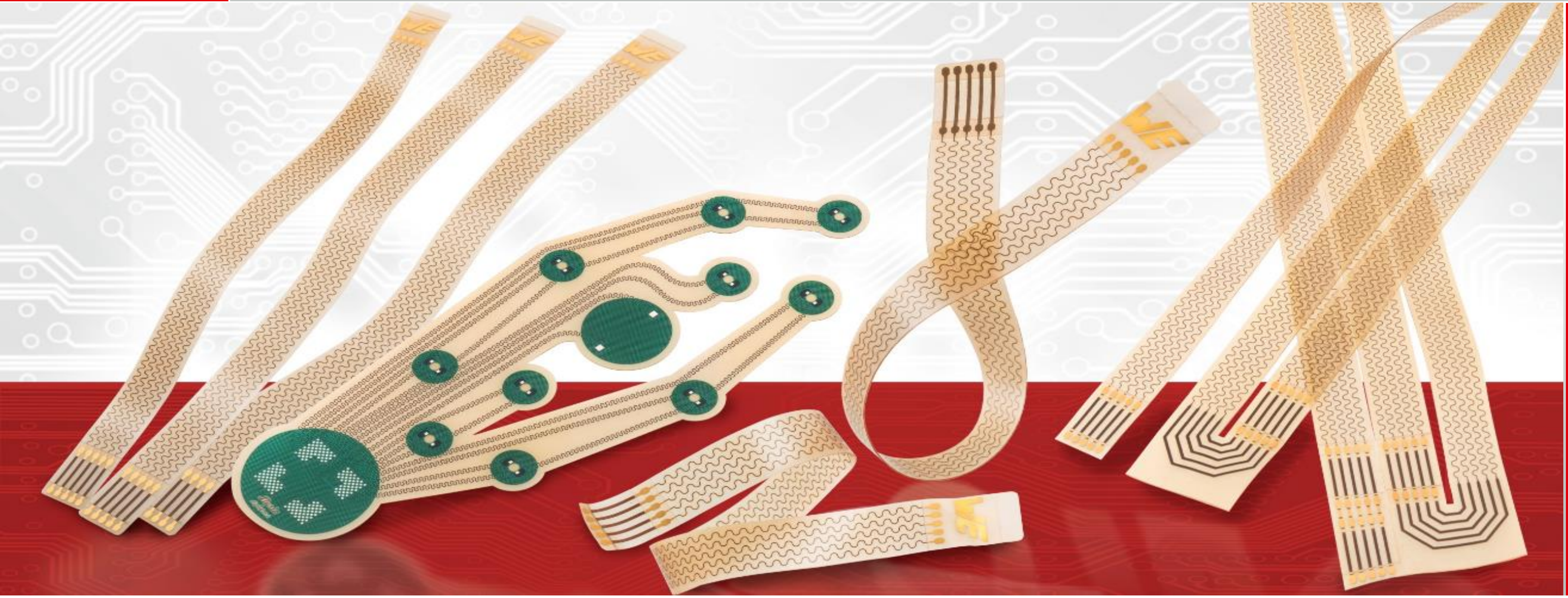
STRETCH.flex – A stretchable printed circuit board Introduction



Jürgen Wolf
Michael Feuerlein
Würth Elektronik GmbH & Co. KG
Circuit Board Technology
Advanced Solution Center

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AGENDA

1 Basic concept of stretchable printed circuit boards

2 Process Flows

3 Design Basics

4 Summary & Outlook on Part II

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1 **Basic concept of stretchable printed circuit boards**

2 Process Flows

3 Design Basics

4 Summary & Outlook on Part II

STRETCH.**flex**

Basics and Concept

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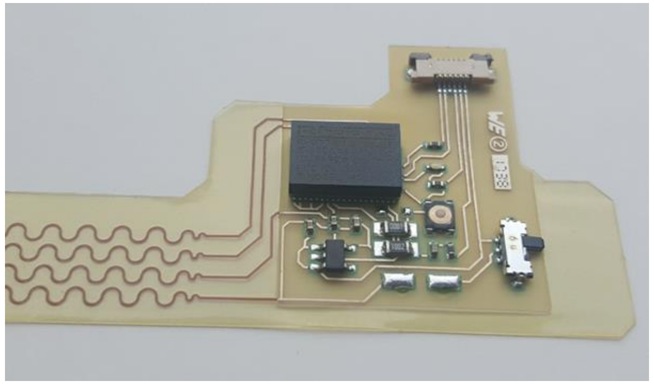
Concept – stretchable printed circuit board

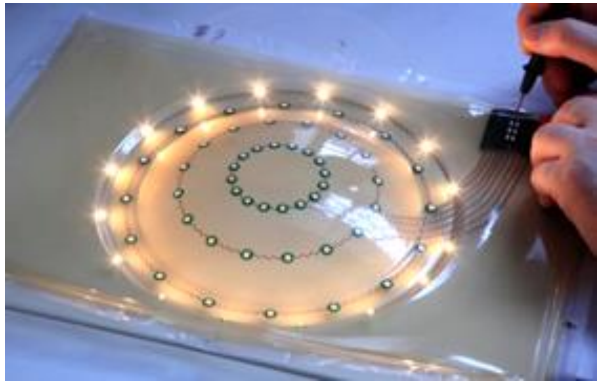
- **Thermoplastic polyurethane (TPU) acts as new copper clad substrate material**
- **Design of the tracks in meander form to realize the stretchability**
- **Use of established manufacturing processes**
- **Various further processing options e.g. thermoforming/deep drawing, back injection moulding, laminating, etc.:**



Assembly with SnBi-solder paste

Laminated onto textiles

Source: Fraunhofer IZM



Example „Conformable Electronics“

Source: Fraunhofer IZM

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Basics and Concept

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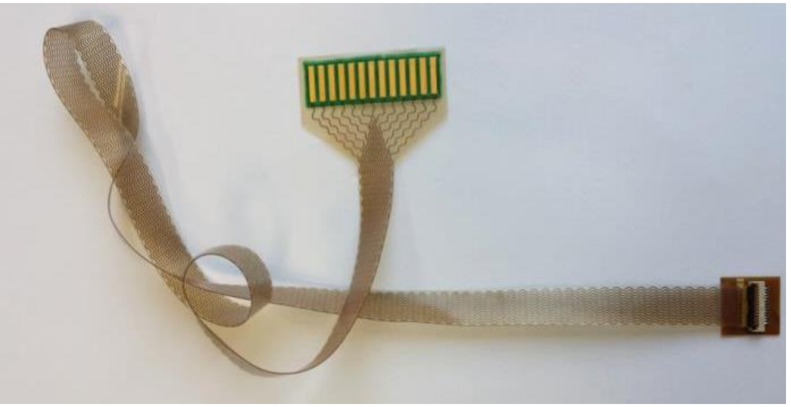
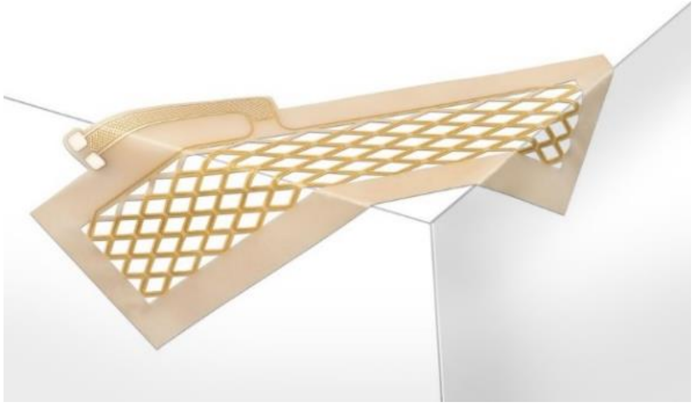
Your advantages

- Depending on the layout: dynamic stretchability of 5 – 20%
- Wide property profile of TPU
- Very adaptable material – almost every shape is realizable
- Multiple rotation without influence on stability and electrical properties

The material and advantages are aimed at applications in
- Medical Technology
- Sensor Technology
- Smart Textiles
- (Soft) Robotics
- Internet of Things (IoT)
- and in your business


Dynamic stretch


Multiple rotation (n x 180°)


Adaptable material

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Properties of TPU (without Copper)

Material properties

- Skin-friendly / biocompatible
- very flexible / limp
- Hydrolysis-resistant
- Microbe-resistant
- Good weathering resistance
- High wear resistance

Chemical properties

- Free from plasticisers/softeners
- Stable against oils, greases, ozone, tar, many solvents and diluted acids

Physical properties

- Softening area 155 – 185°C
- Thermal decomposition as of 250°C
- Fracture strain 500%
- Elastic over a wide temperature range
- UV and radiation resistant

Electrical properties

- Dielectric constant: 4,4
- Dielectric strength:
  Dry: 9,0 kV/100µm
  Humid (80% r.H.): 7,5 kV/100µm

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Basics and Concept – Process Flow / Manufacturing Concept

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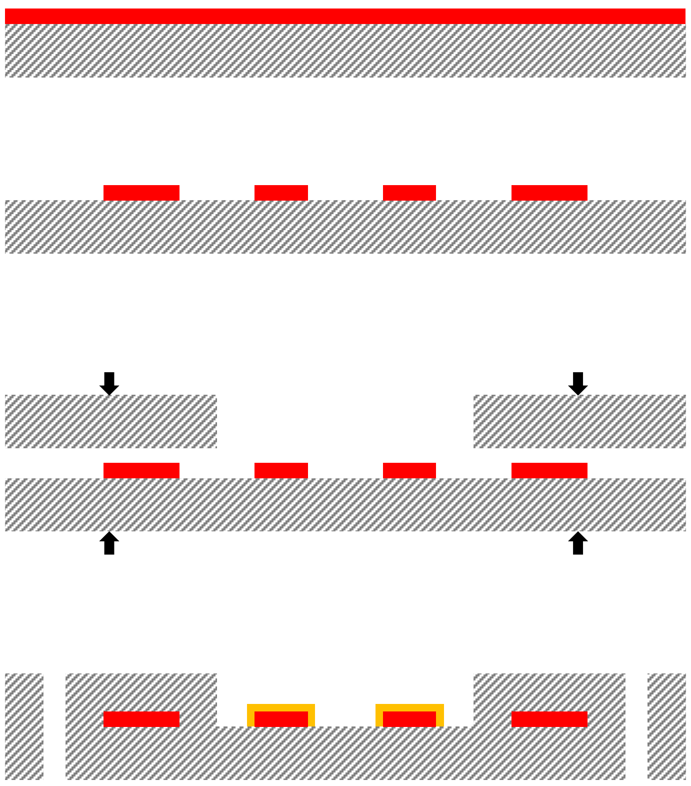
Single-sided (1S) stretchable PCBs



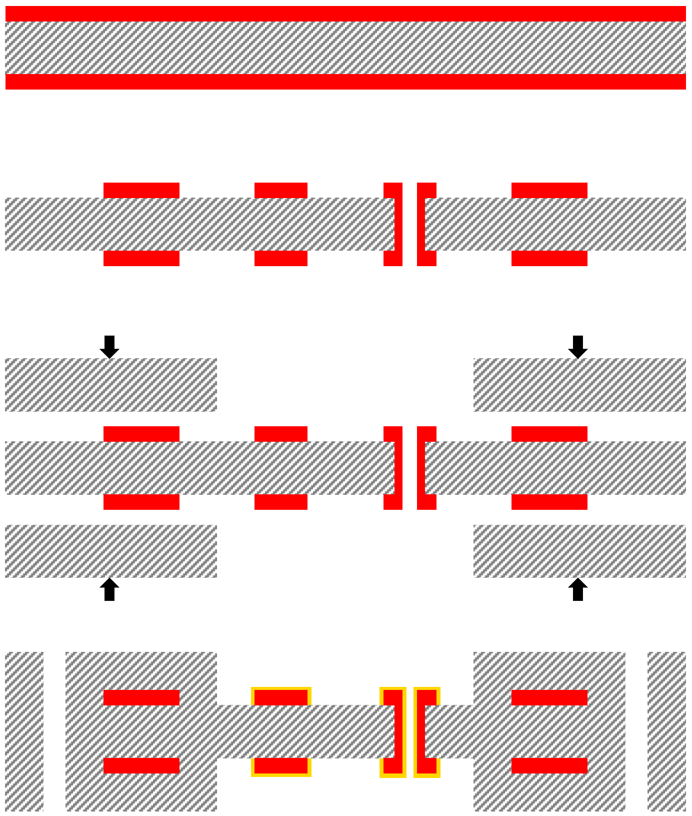
Copper clad
TPU

if necessary drilling of vias and
structuring of copper

lamination of
pre-structured TPU

solder surface and
final routing

Double-sided (2S) stretchable PCBs



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Basics and Concept

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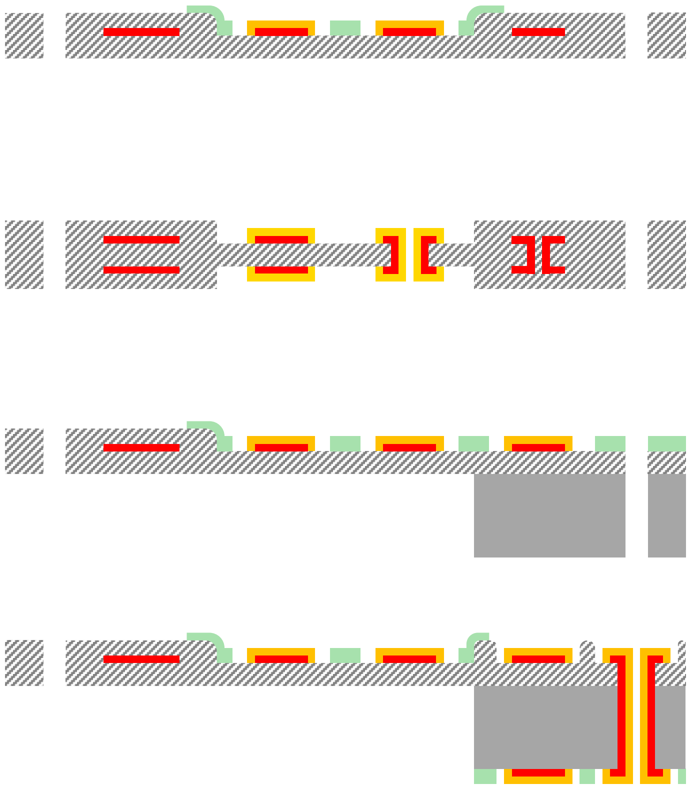
Nomenclature – single-sided (1S) and double-sided (2S) stretchable printed circuit boards

- **1S**
- **2S**
- **1S-0Ri**
- **1S-1Ri**



Legend

- TPU
- Copper
- Solder Surface
- FR4
- Solder Resist

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Short Poll

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POLL

Which factors have an influence on the stretchability?

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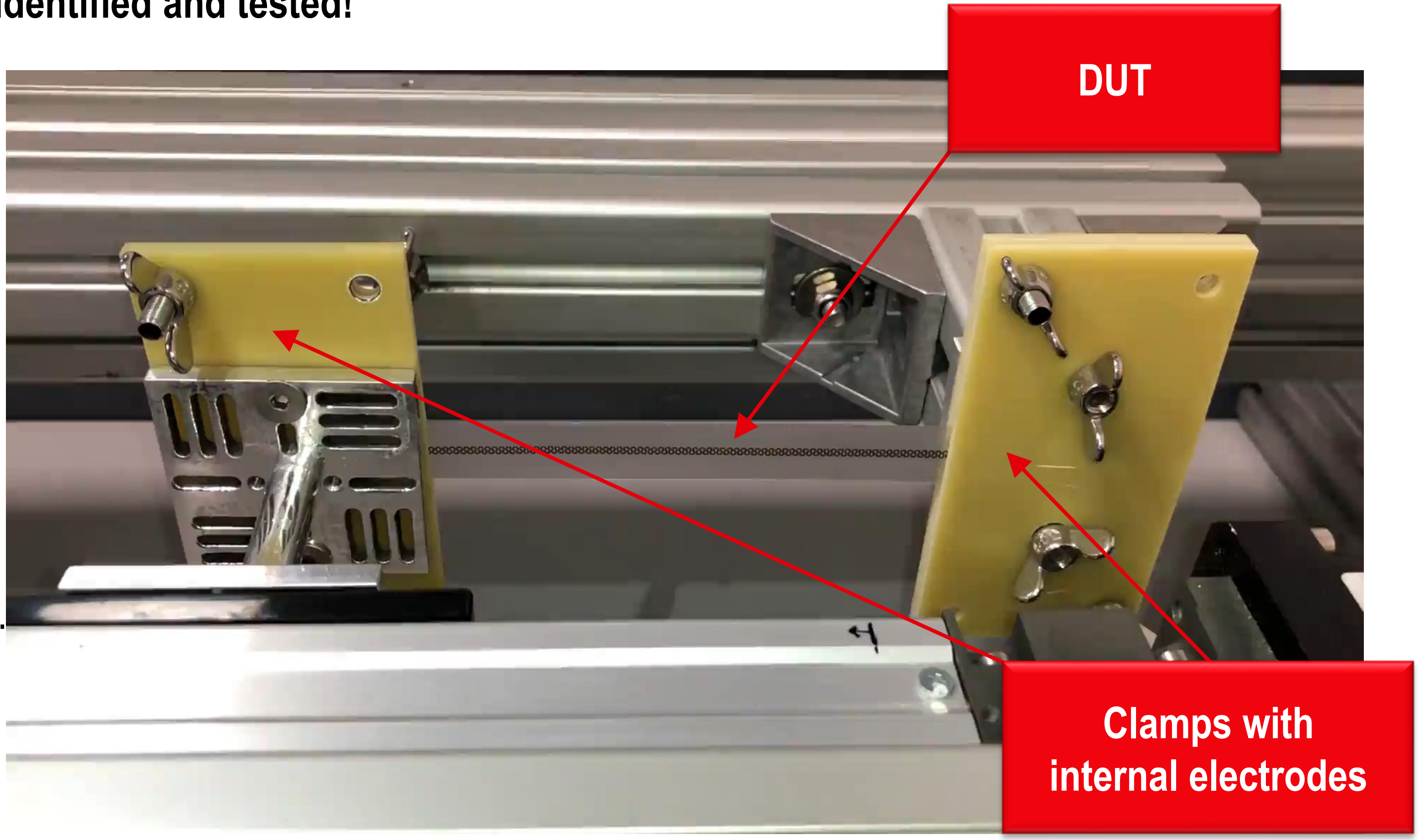
Investigations into the Elongation of Copper Structures

- **New reliability requirements must be identified and tested!**
- **Example:**
  Cycling strength of different copper structures at defined elongation
- **Approach:**
  - production of dedicated samples
  - construction of a device for cyclic stretching with in-situ measurement
  - and measure, measure, measure…
- **The resistance is measured at the min. and max. elongation points**



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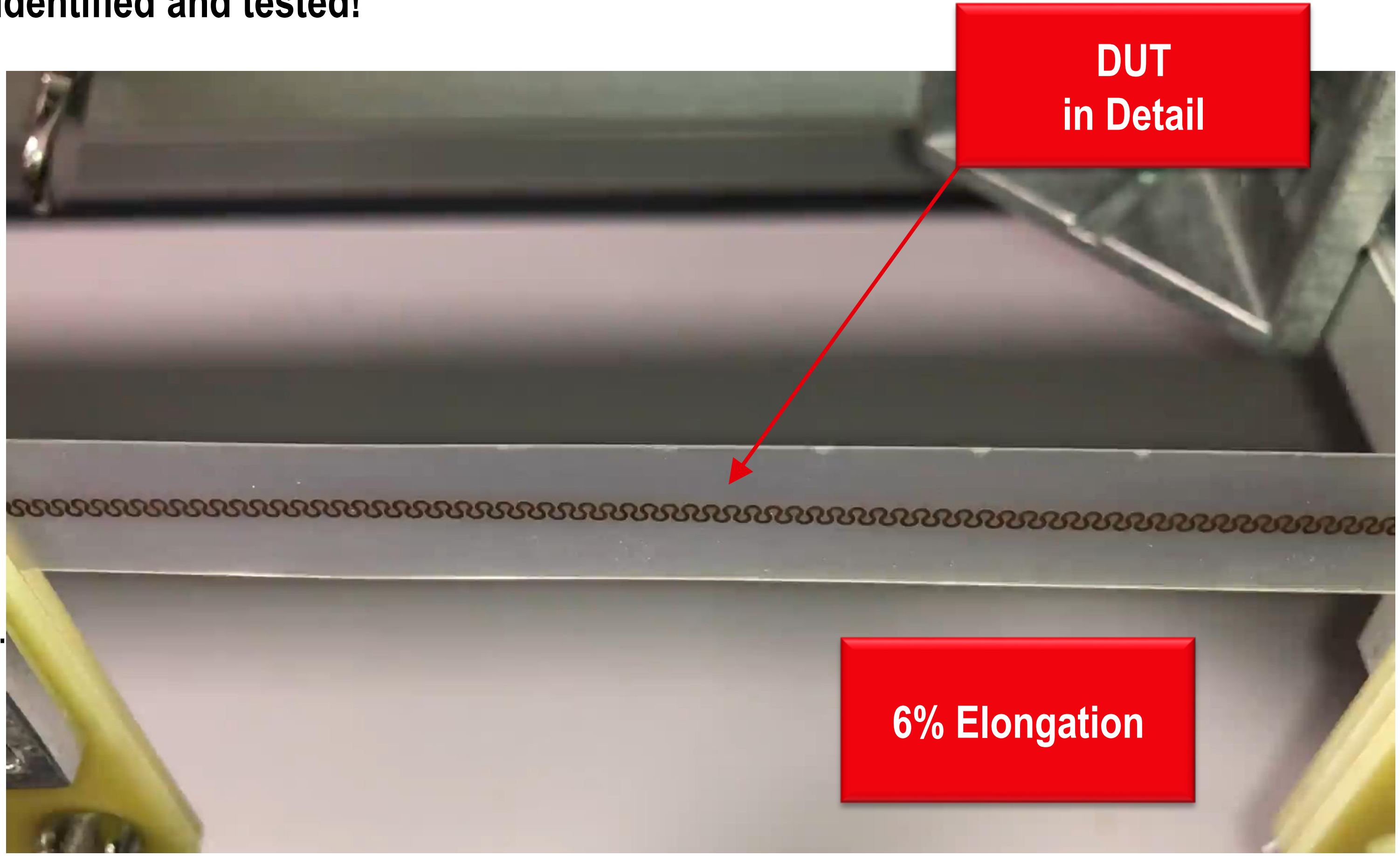

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Investigations into the Elongation of Copper Structures

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- **Approach:**
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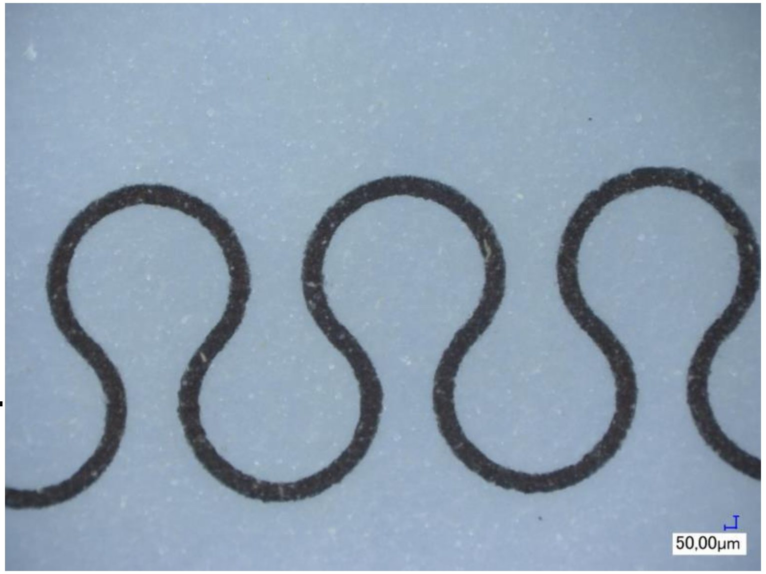
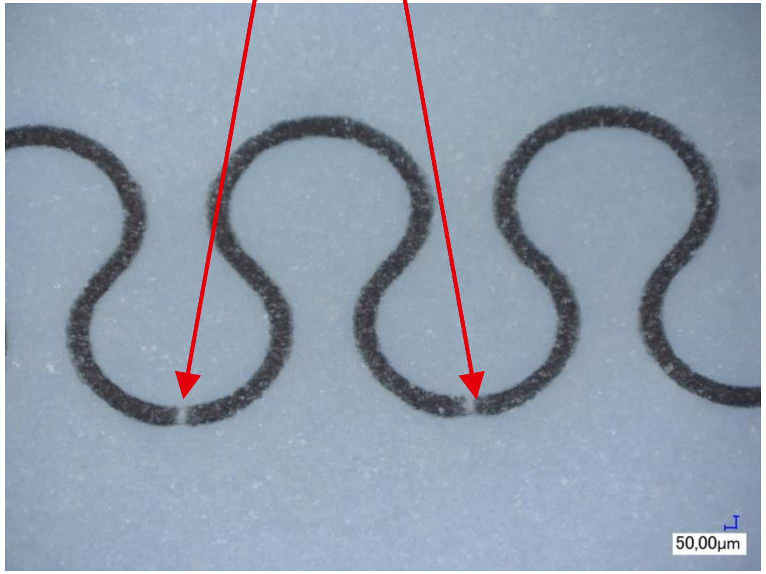
  - construction of a device for cyclic stretching with in-situ measurement
  - and measure, measure, measure….
- **The resistance is measured at the min. and max. elongation points**
- **Defect is being evaluated**



„Horseshoe“ before cyclic stretching



„Horseshoe“ after cyclic stretching

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Design Basics – Elongation of Copper Structures

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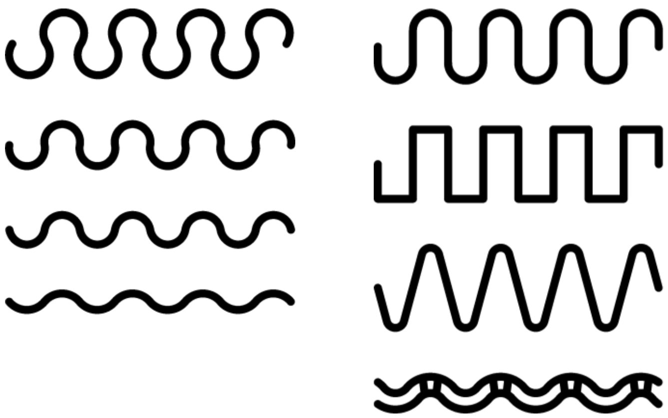
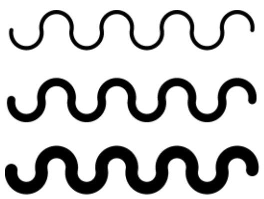
- **Meandering shapes**

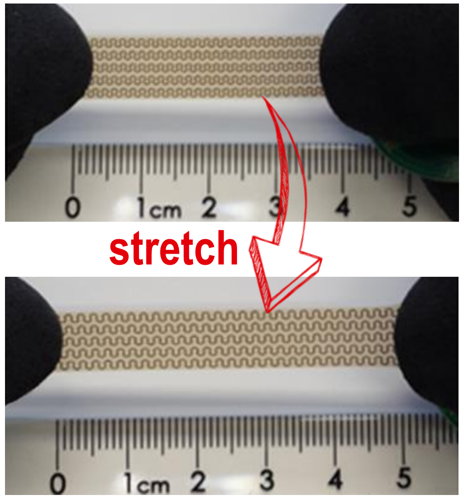


- **Track width and spacing**



100 µm
200 µm
300 µm

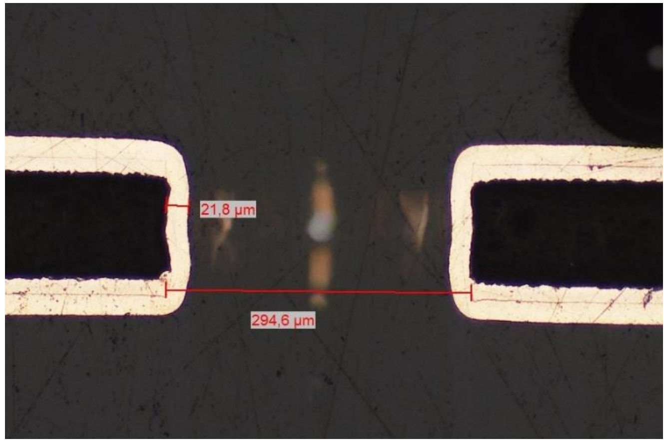
- **Exemplary Stretching**



- **Of course, your own meander designs are also possible!**

- **Through holes**

  Drilling diameter
  Ø 0,25 – 0,70 mm



- **Different copper end thicknesses are possible**

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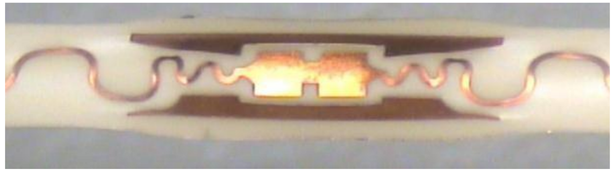
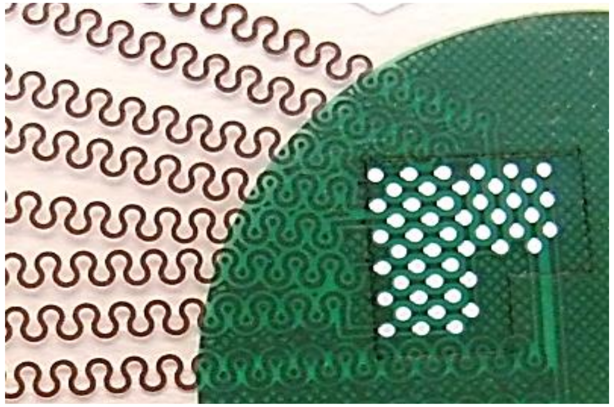
Design Basics – Further Design Parameters

- **Local Copper reinforcement in the assembly areas**

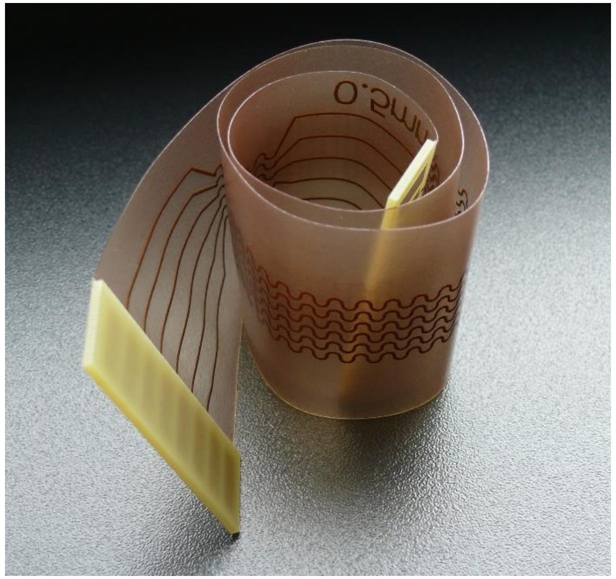
- **Reinforcement in the assembly area by reducing the meander amplitude**



- **Stabilisation of the assembly areas through mesh structures**
- **Partially applied solder resist in the assembly area**



- **FR4 Stiffener (shown on an 1S-0Ri)**



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Short Poll

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POLL

Which meandered track will break first?

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Outlook for Part II

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You will receive the results of the survey in part II of the webinar on 04.05.2021 ☺
Then we will continue with the following topics:

- **More detailed insights into the different layout forms and their reliability**
- **Implementation in EDA-Tools?**
- **How to assemble STRETCH.flex PCBs?**
- **Application examples**

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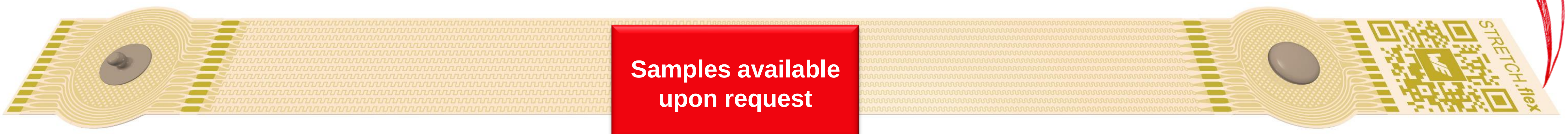
Summary

Material properties

- Extensive testing necessary
- Multiple rotation (n x 180°) without influence on stability and electrical properties
- Dynamic stretchability of 5 – 20 %
- Skin-friendly material
- Softening area: 155 – 185°C
- Multiple processing options (assembly in reflow, thermoforming/deep drawing, laminating…)

Fields of application

- Medical Technology
- Sensor Technology
- Smart Textiles
- (Soft-) Robotics
- IoT (Internet of Things)
- Wearable Technology



Samples available upon request

THANKS FOR YOUR ATTENTION!

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What kind of application do you have?

www.we-online.com/stretch

How can WE support you?

Contact:
Würth Elektronik GmbH & Co. KG
Advanced Solutions Center
+49 7940 946-1234
stretch@we-online.com