STRETCH.FLEX 2.0 – WE STRETCH THE LIMITS OF DESIGN!

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Co- Autor: Jürgen Wolf

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

AGENDA

STRETCH.flex 2.0 – we stretch the limits of design!

1. Review
2. Results of Stretchability
3. Layouting in EDA-Tool
4. Assembly of components
5. Applications

Michael Matthes
WEdesign / Specialist
Layout and Measurement

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ASC/ Technische Projektmanagerin

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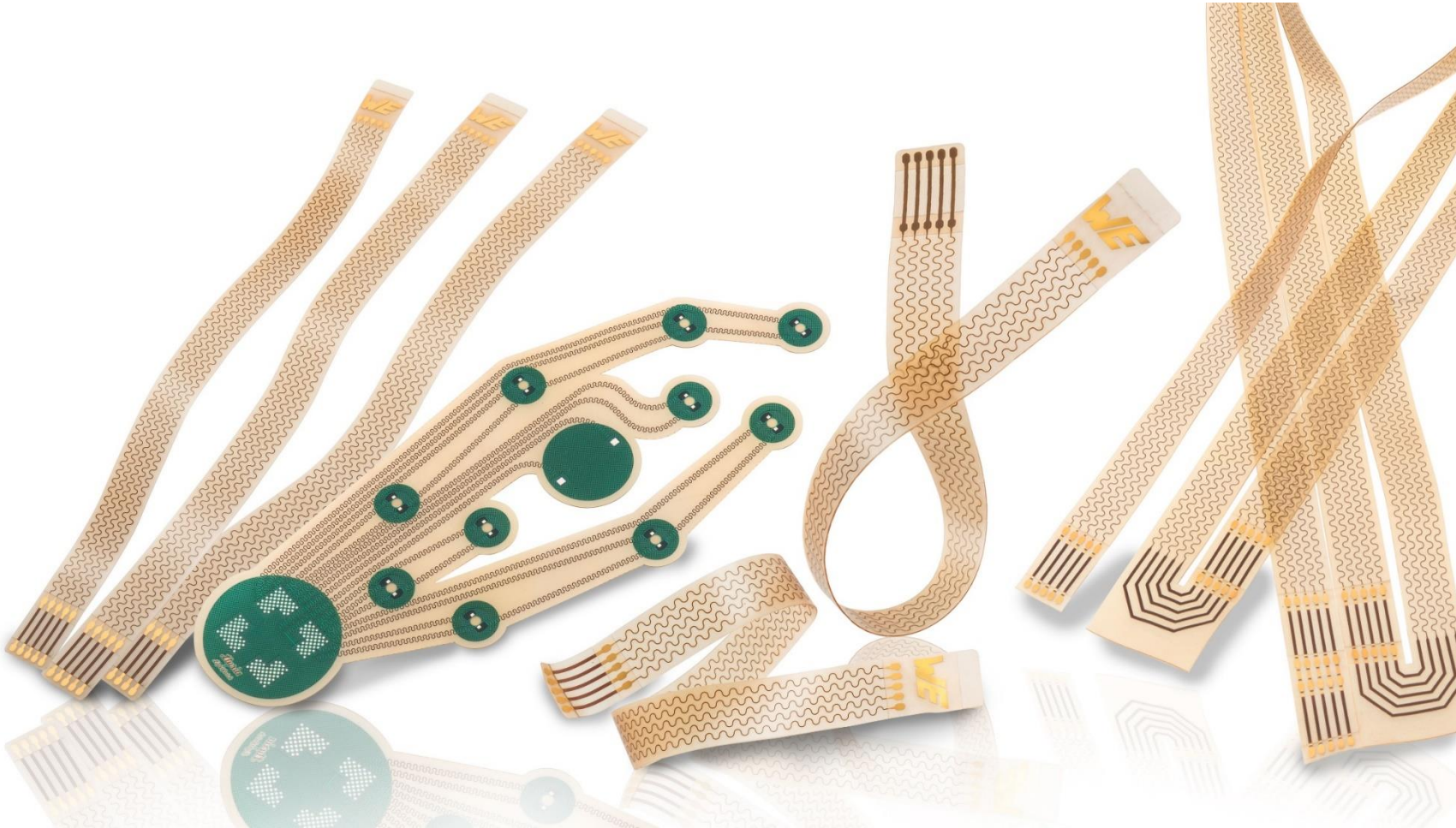
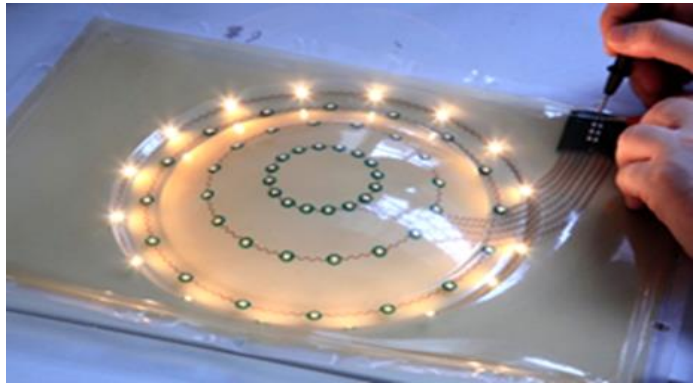


Review

- Thermoplastic polyurethane (TPU) acts as new copper clad substrate material
- Design of the tracks in meander form to realize the stretchability
- Various further processing options e.g. thermoforming/deep drawing, back injection moulding, laminating, etc.:
- Wide property profile of TPU e.g. skin-friendly, free from softeners, UV and radiation resistant

Laminated onto textiles

Source: Fraunhofer IZM



Example „Conformable Electronics“

Source: Fraunhofer IZM

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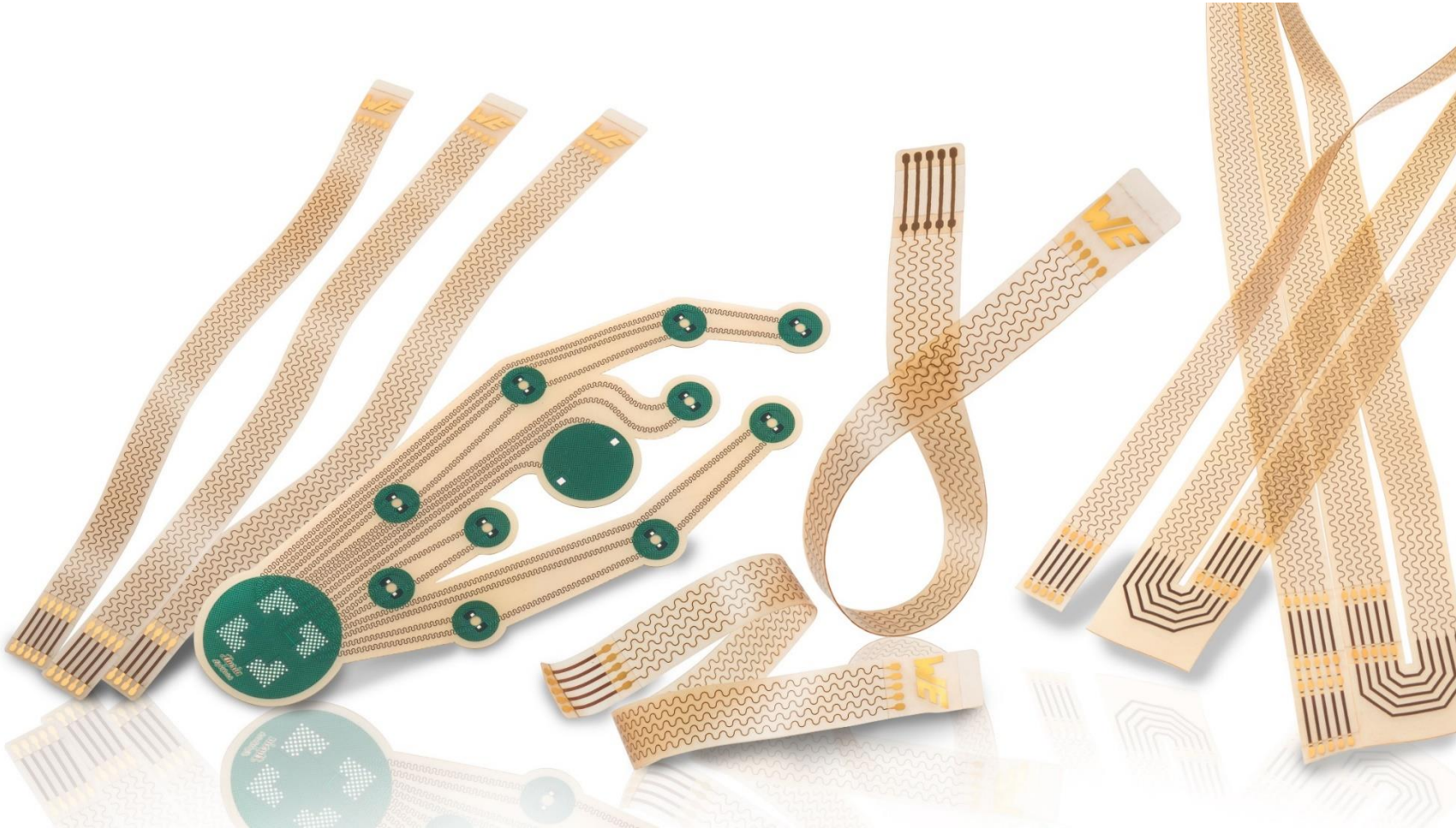
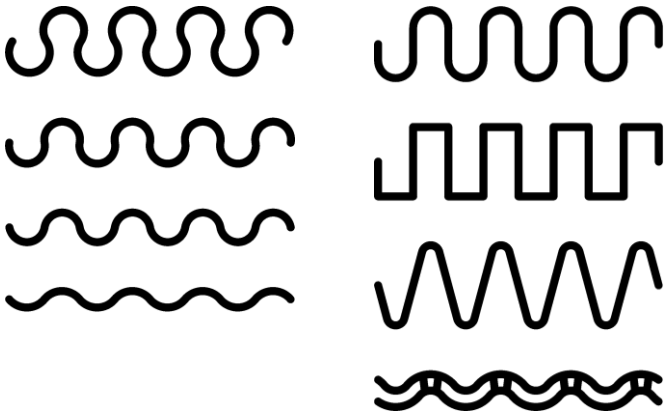


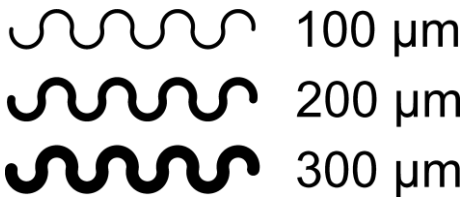
BASICS

Possibilities for the design

- Stretchability of the tracks is realized with tracks in meander form

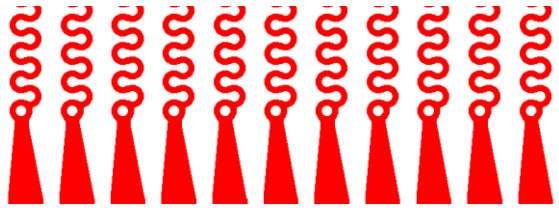


- Track width and spacing

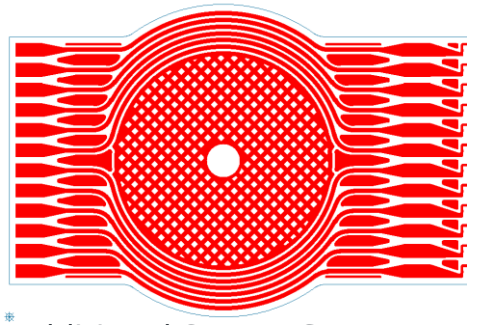


- Final copper thickness
  - 18 µm
  - 35 µm

- Transition between rigid and stretchable area

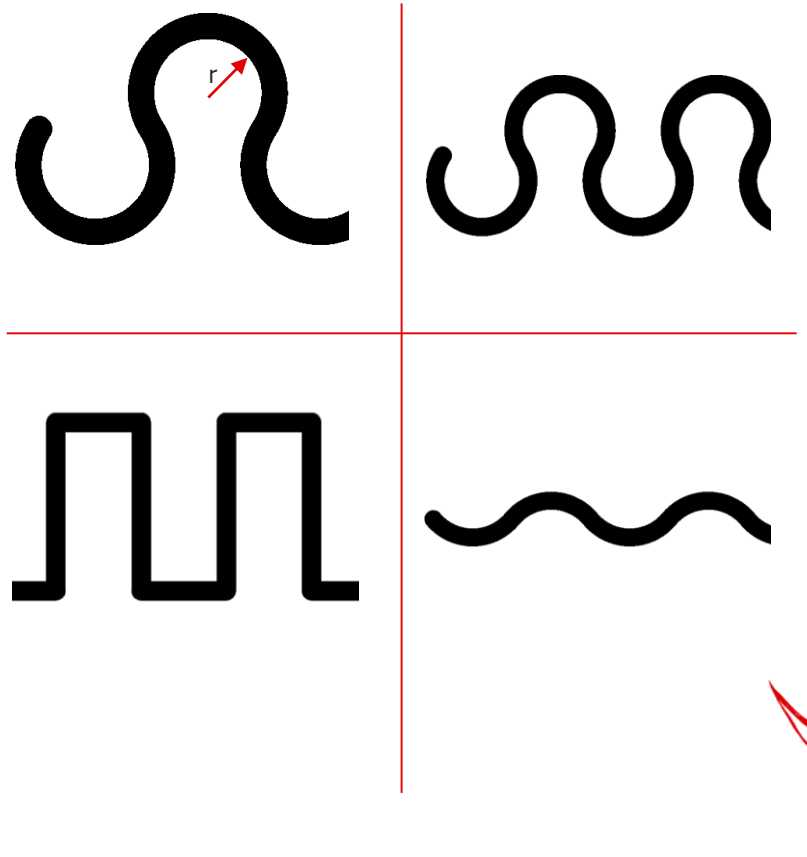


Donut-Structure



Additional Copper Structure

ELONGATION – ROUGH ANALYSIS OF MEANDER STRUCTURE

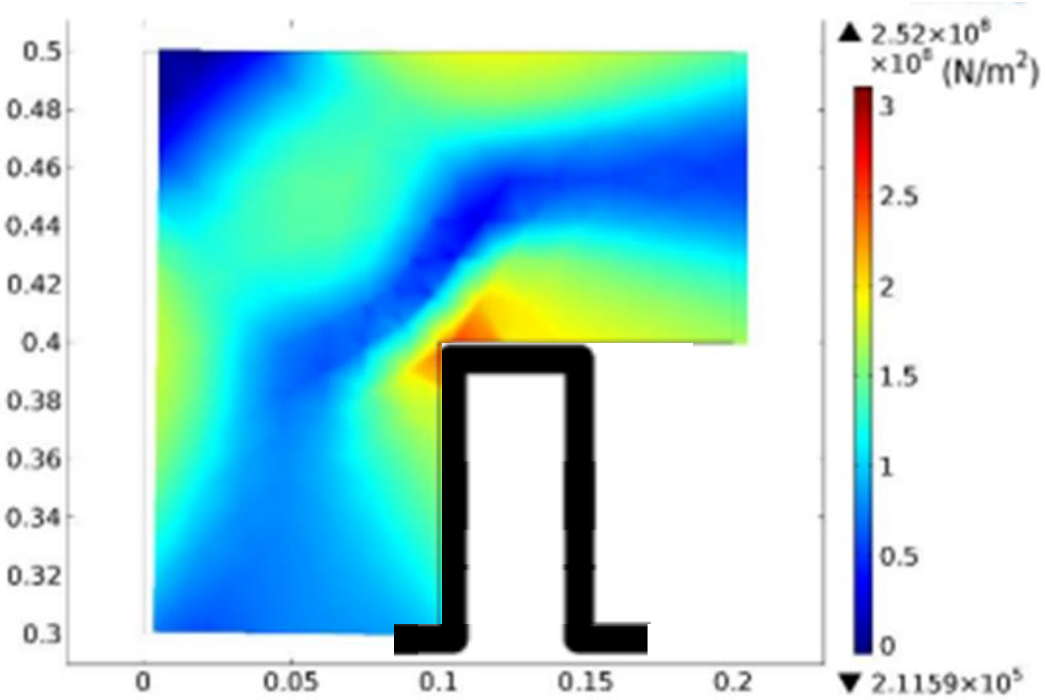


Meanderstyle*	Cycles 5%	Cycles 10%	Cycles 20%
Horseshoe big	2650	509	92
Horseshoe small	4499	742	129
Rectangle	8585	1122	139
Wave	2288	406	61

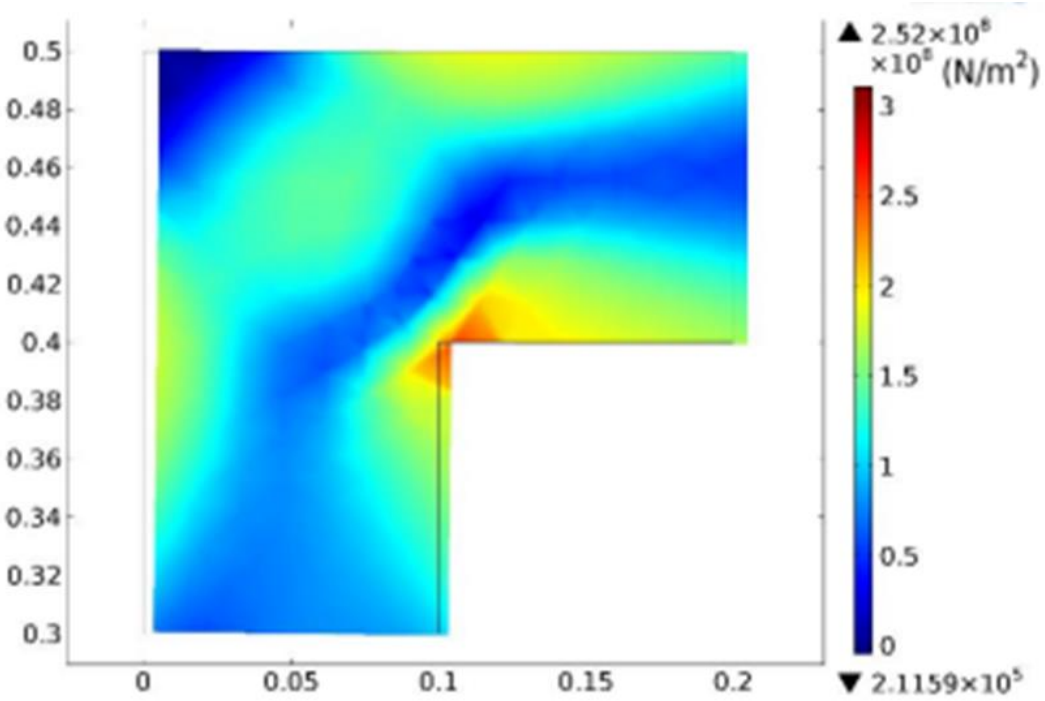
The greater the elongation, the fewer cycles can be achieved.
Best result: Rectangular structure

*Source: Order investigation Fraunhofer IZM

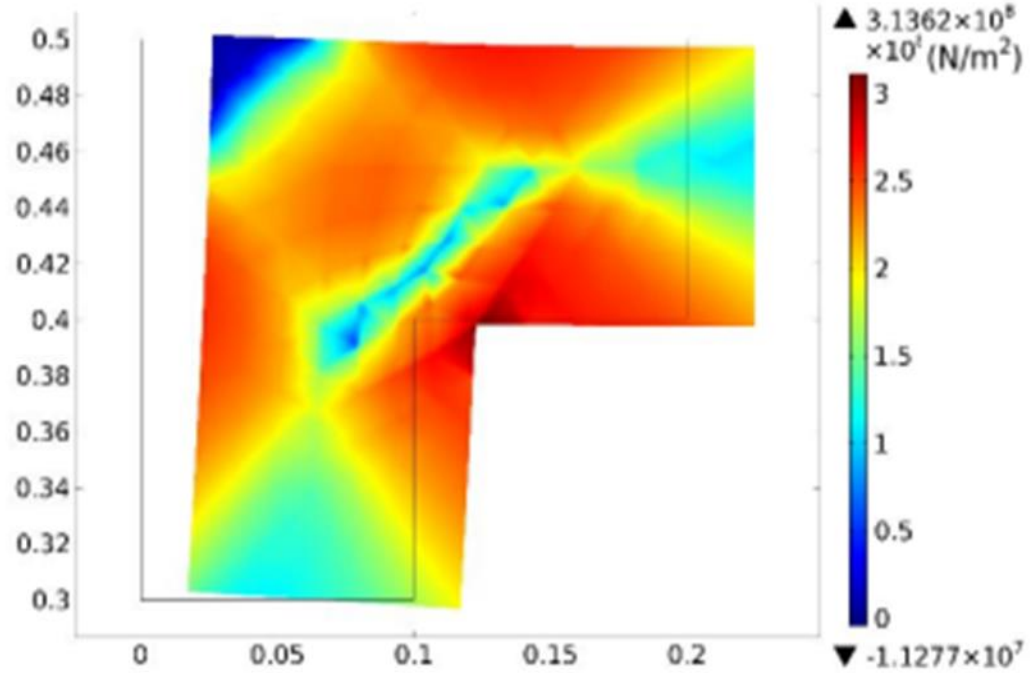
ELONGATION – ROUGH ANALYSIS OF MEANDER STRUCTURE



ELONGATION – ROUGH ANALYSIS OF MEANDER STRUCTURE



1% elongation

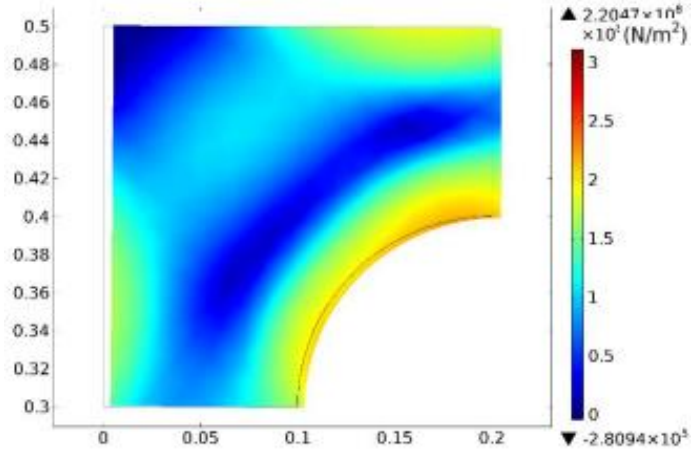


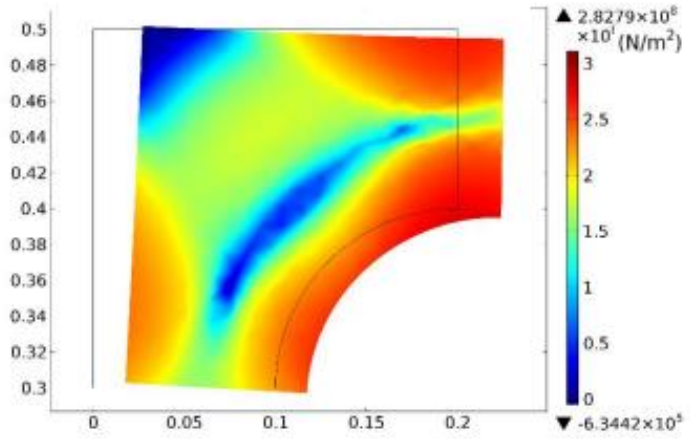
5% elongation

ELONGATION – ROUGH ANALYSIS OF MEANDER STRUCTURE

- Radii of the rectangles are adjusted by FEM simulation
- Goal: Show optimization potential

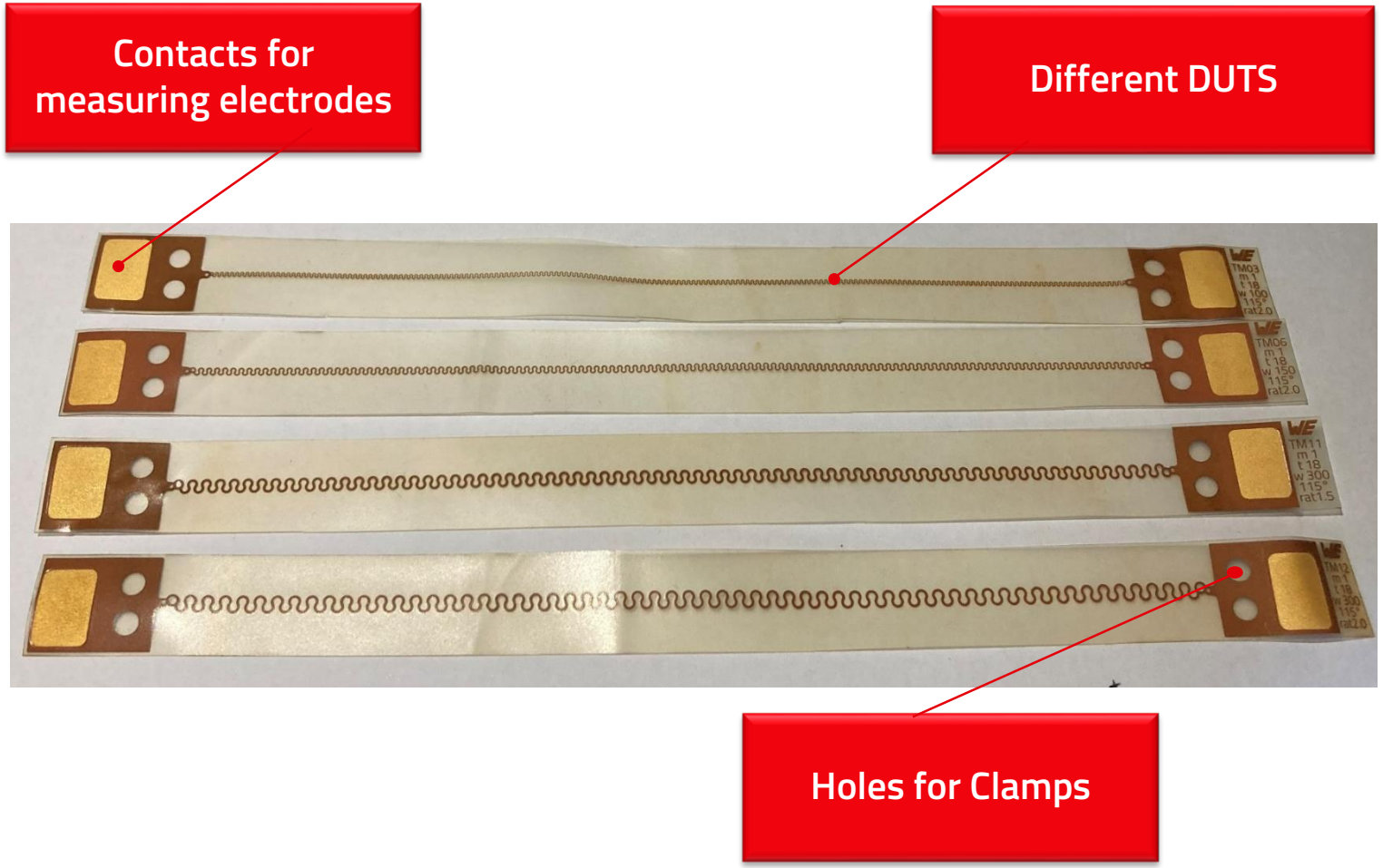
At 100 µm radius, stress values decrease by approx. 10%.





ELONGATION - FINE ANALYSIS

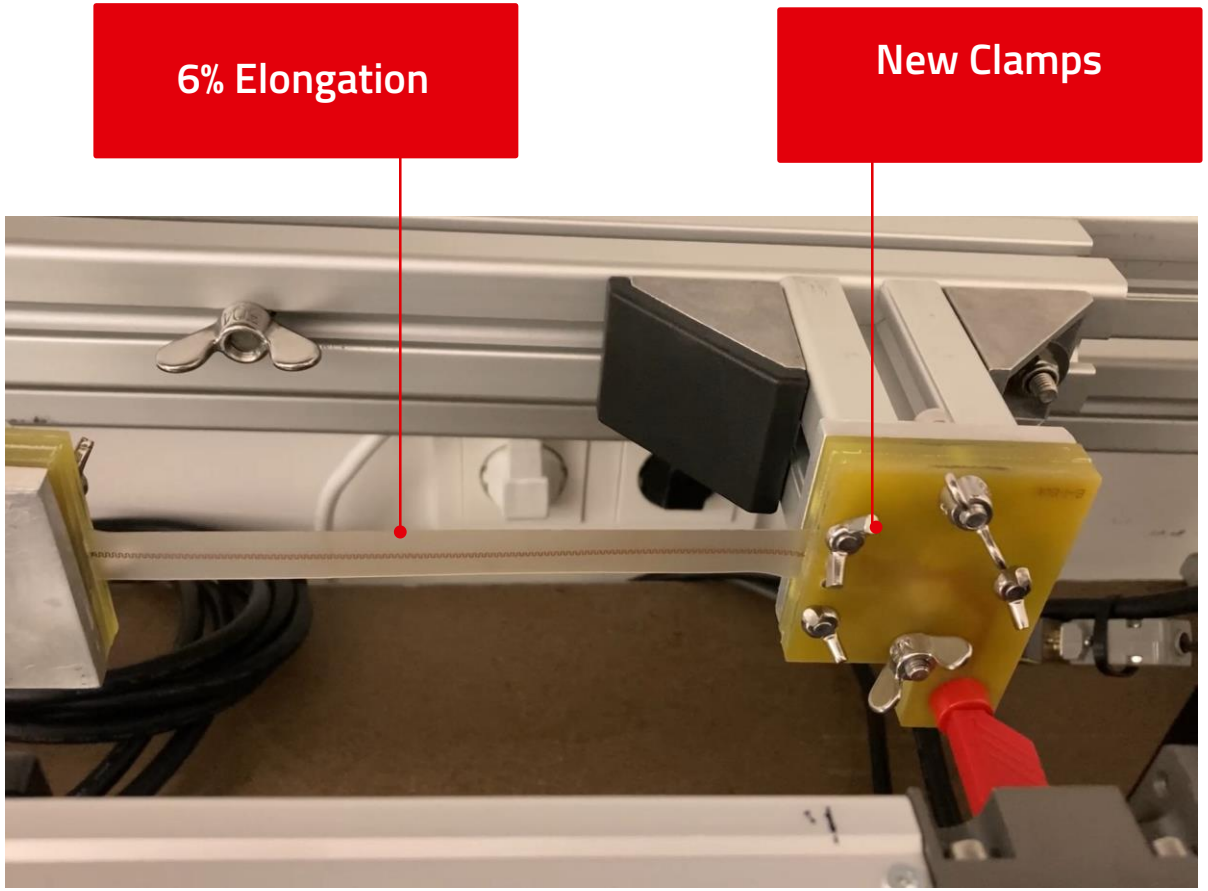
- Improved structure of expansion system and receptacles
- Physically tested approx. 1200 meander structures
- Differentiation in terms of
  - Track Width
  - Opening angle
  - Ratio
  - Meander Structure



ELONGATION - FINE ANALYSIS

- The resistance is measured at

  the min. and max. elongation points
- Promising layouts are simulated with FEM simulation
- Tests still on going



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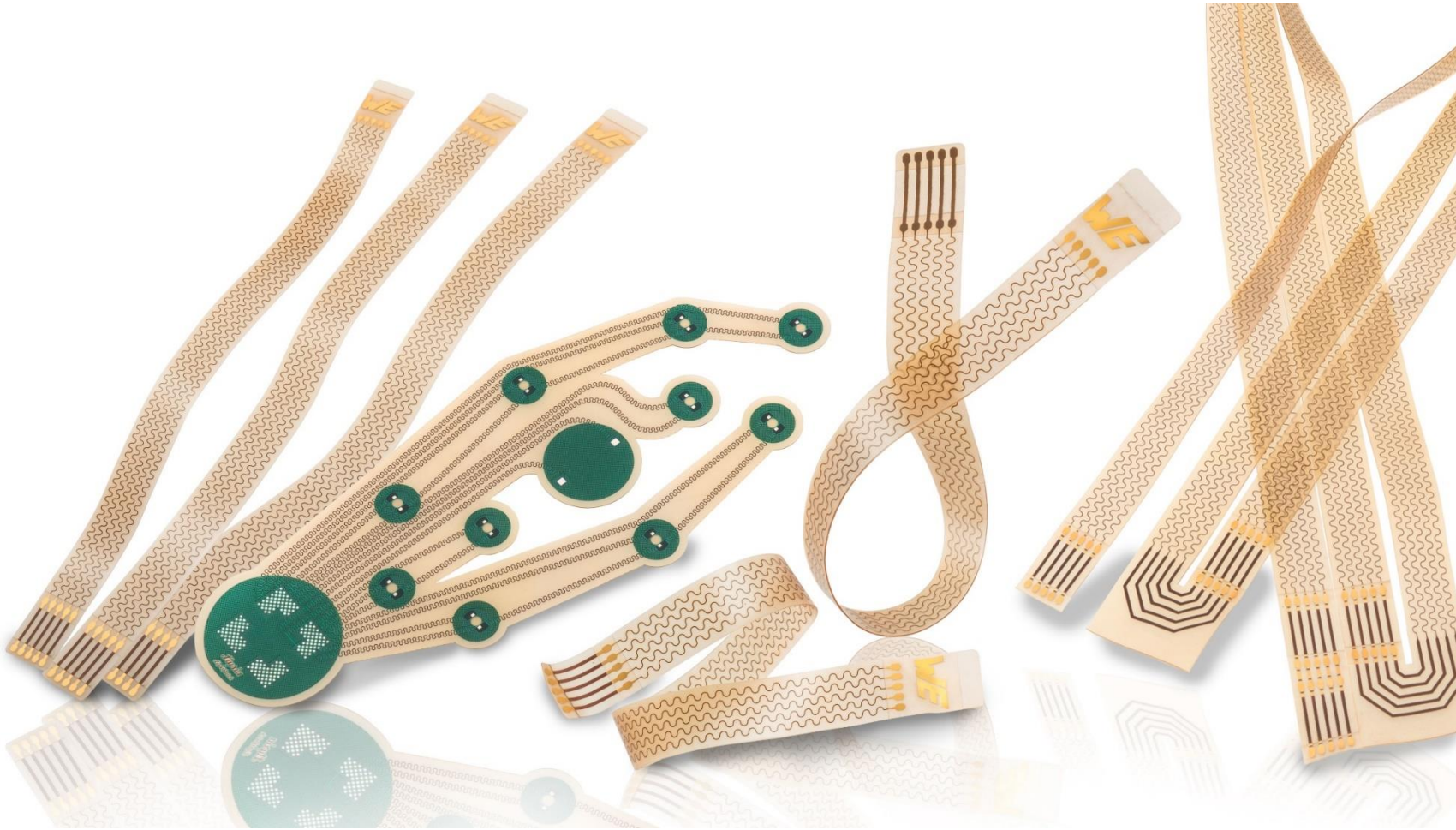


DESIGN TOOL POSSIBILITIES

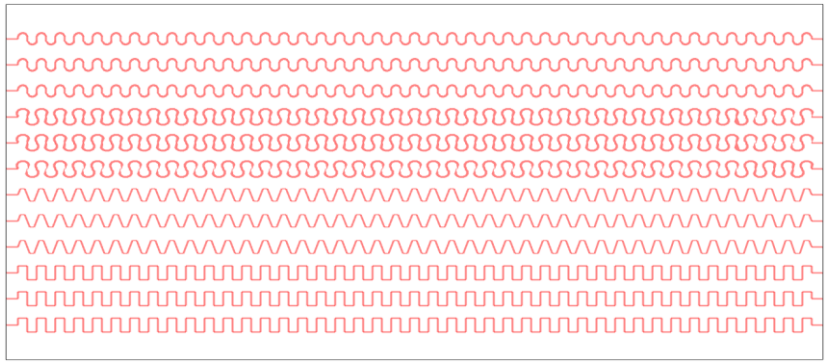
Meander structures generated in the tool

Live - Demo

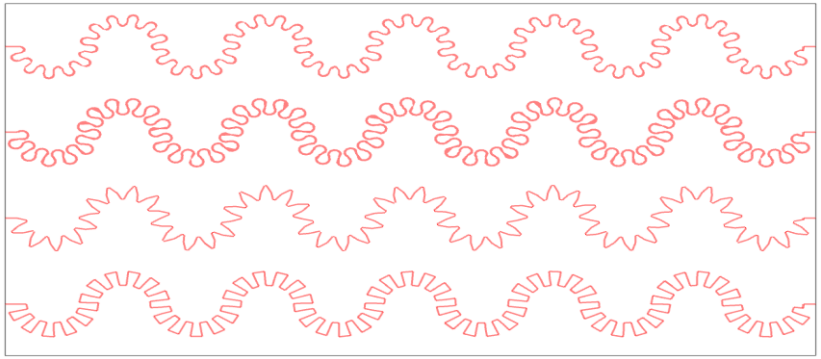
OPPORTUNITIES FOR DESIGN-TOOL

Meander structures generated in the tool

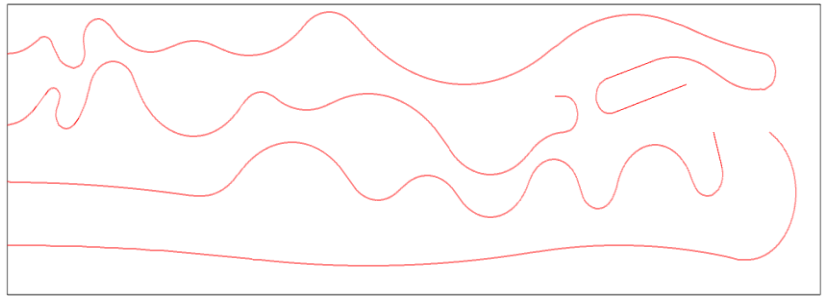
- different meander styles:
Full Arc, Snake, Triangular and Square



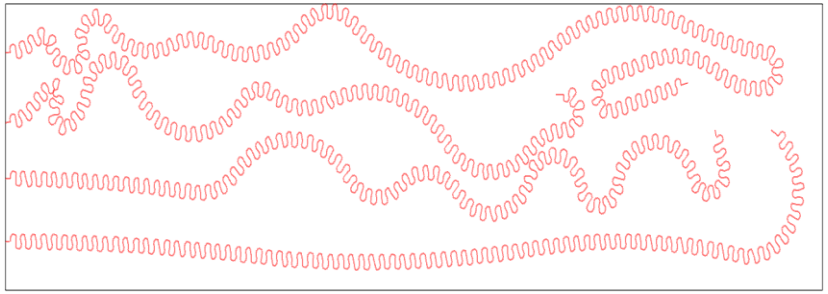
- various meanders superposed to sinusoidally designed basic structure



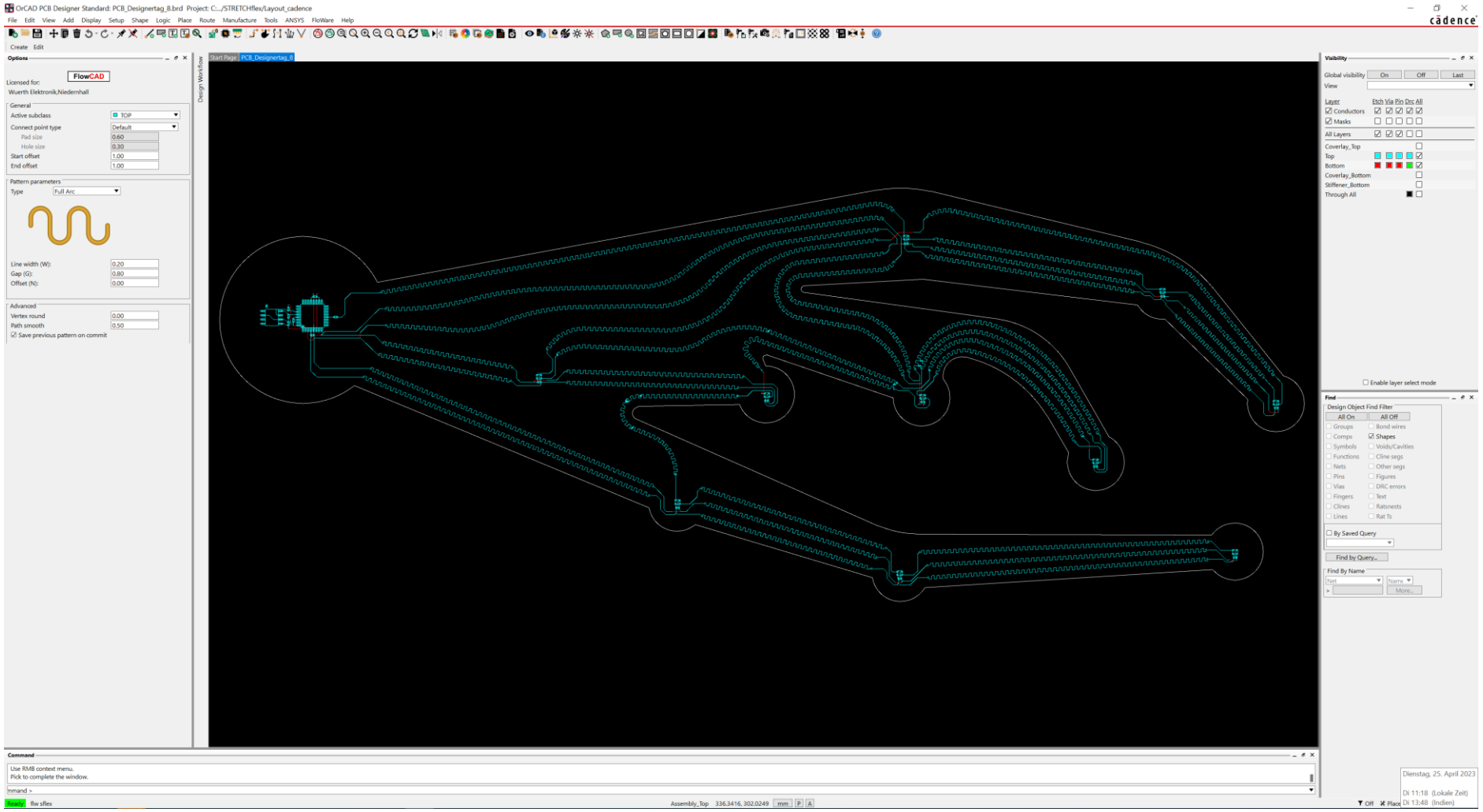
- arbitrarily routed and rounded traces



- traces overlaid with full arc meanders



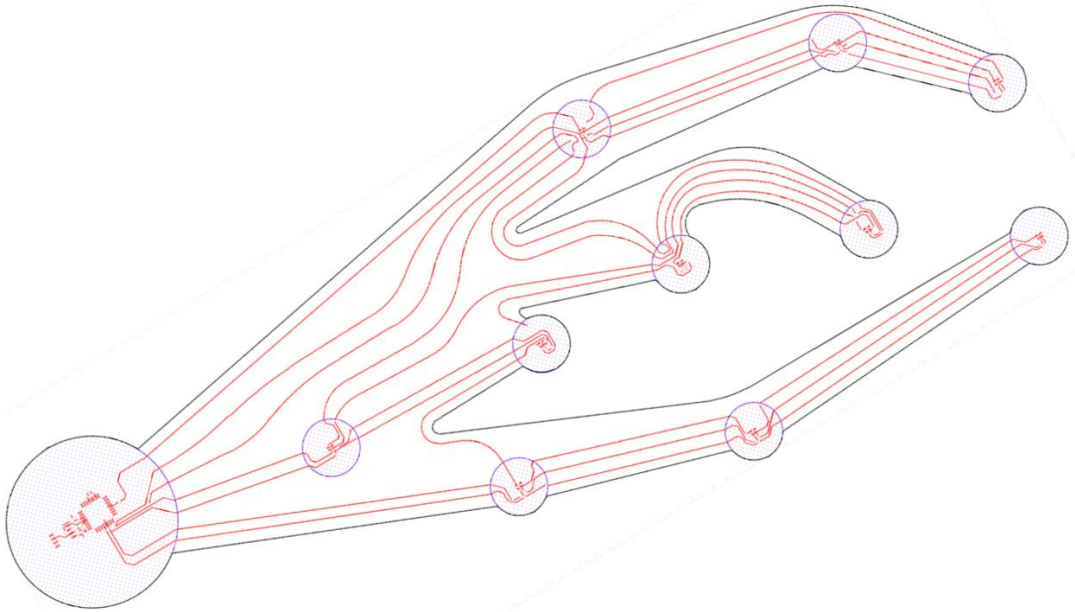
EDA-TOOL


OrCAD PCB Designer Standard: PCB_Designertag_8.brd Project: C:.../STRETCHflex/Layout_cadence
cadence
Options
FlowCAD
Licensed for:
Wuerth Elektronik,Niedernhall
General
Active subclass
Connect point type
Start offset
End offset
Pattern parameters
Type
Full Arc
Line width (W):
Gap (G):
Offset (N):
Advanced
Vertex round
Path smooth
Save previous pattern on commit
Start Page
PCB_Designertag_8
Design Workflow
Visibility
Global visibility
Layer
Conductors
Masks
All Layers
Coverlay_Top
Top
Bottom
Coverlay_Bottom
Stiffener_Bottom
Through All
Enable layer select mode
Find
Design Object Find Filter
All On
All Off
Groups
Comps
Symbols
Functions
Nets
Pins
Vias
Fingers
Clines
Lines
Bond wires
Shapes
Voids/Cavities
Cline segs
Other segs
Figures
DRC errors
Text
Ratsnests
Rat Ts
By Saved Query
Find by Query...
Find By Name
Command
Use RMB context menu.
Pick to complete the window.
Assembly_Top 336.3416, 302.0249
Dienstag, 25. April 2023
DI 11:18 (Lokale Zeit)
DI 13:48 (Indien)

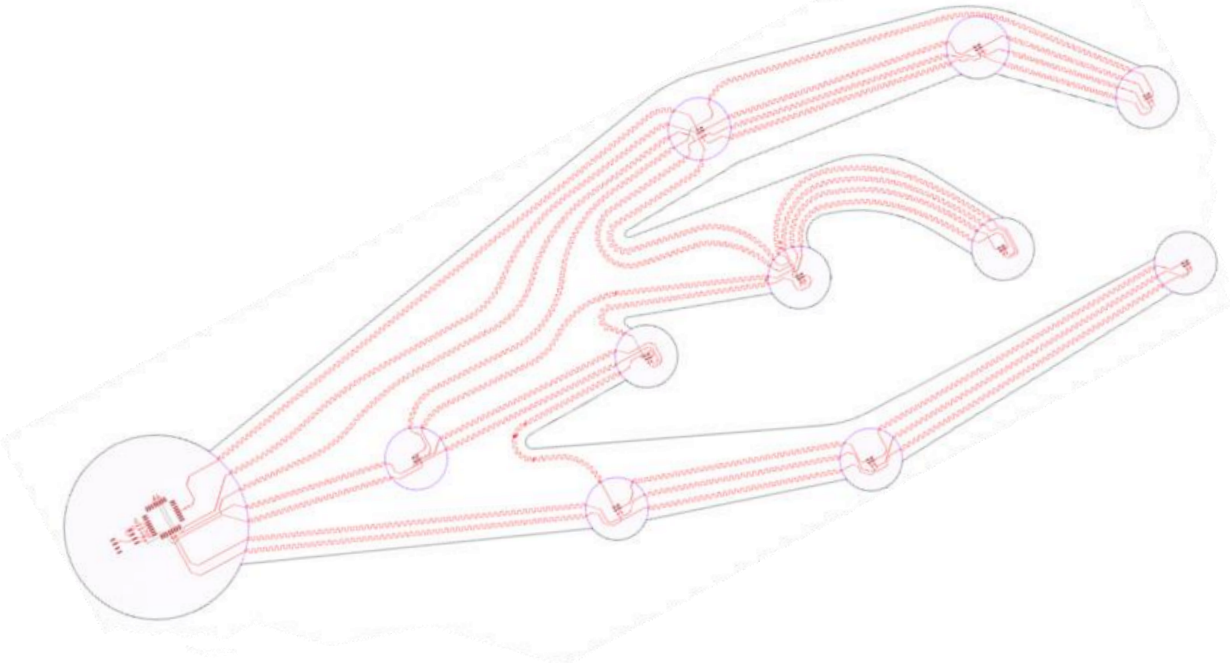
OPPORTUNITIES FOR DESIGN-TOOL

Opportunities for Design-Tool

- prepared stretch design with rounded traces



- complete design is provided with previously selected meander structures at the push of a button

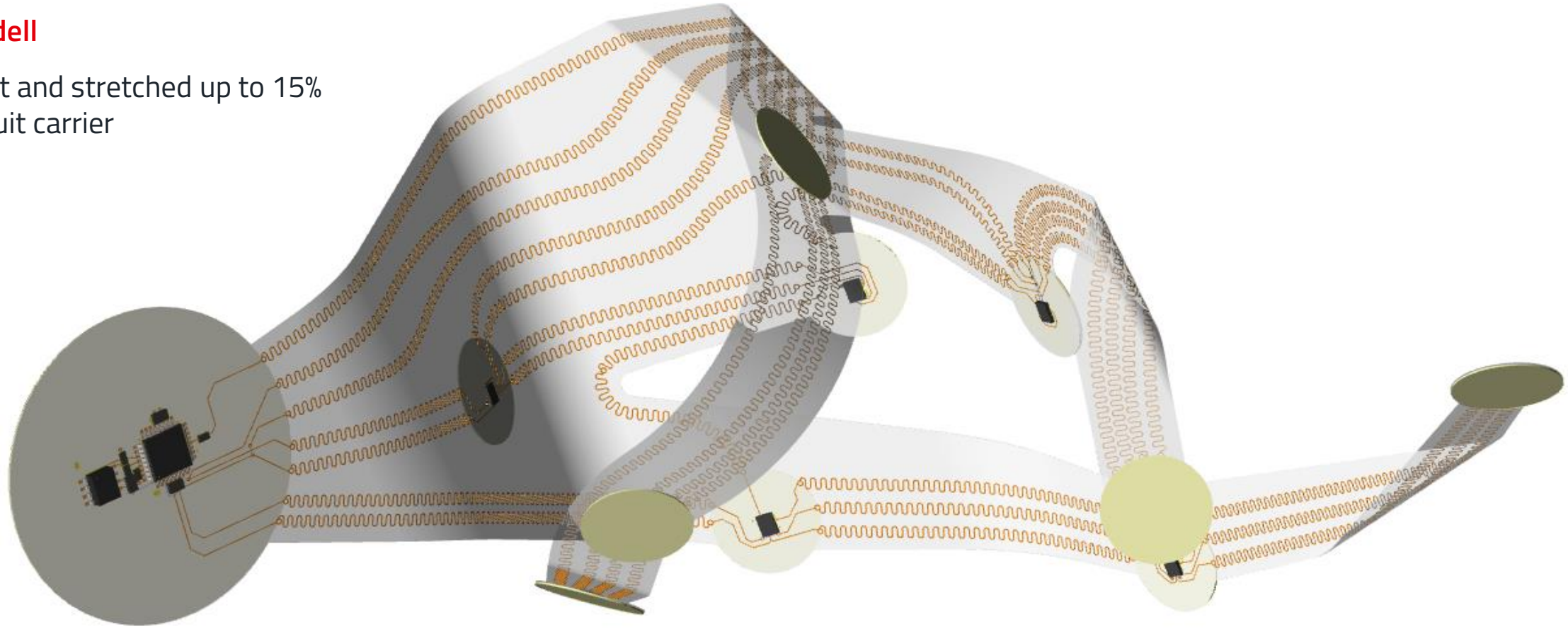


STRETCH.FLEX

Opportunities for Design-Tool

3D Modell

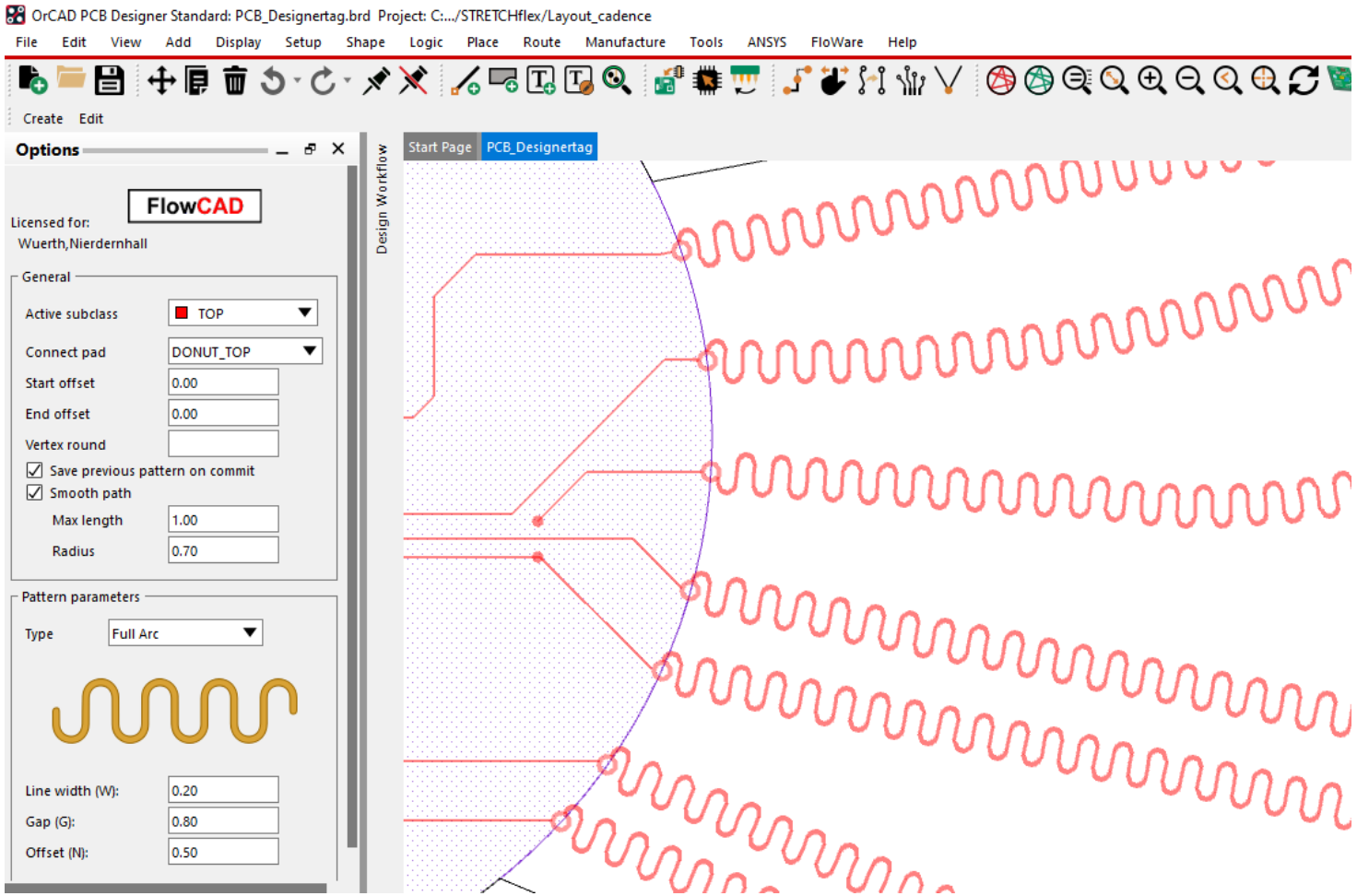
- Bent and stretched up to 15% circuit carrier



OPPORTUNITIES FOR DESIGN-TOOL

Allegro

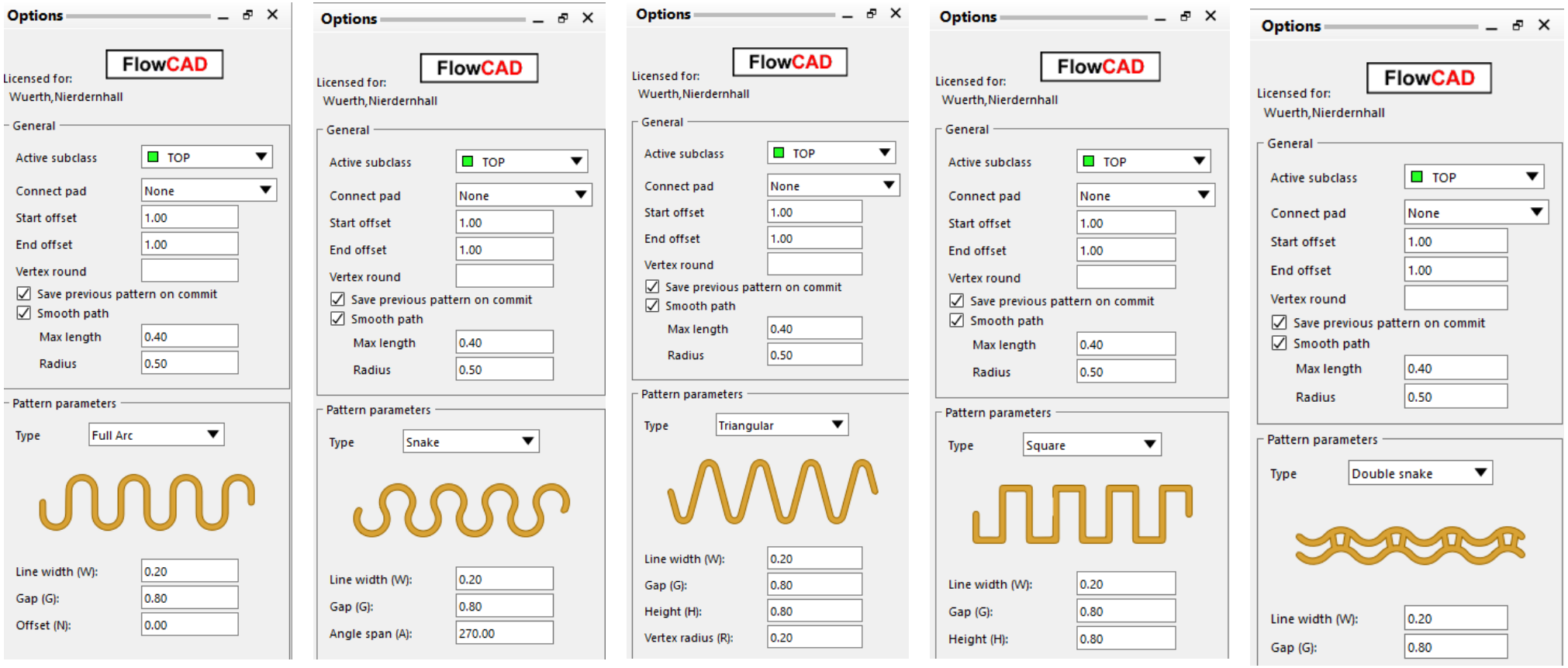
- Control panel with selection option of the different patterns and their parameters such as linewidth, space, radius, offset, etc.
- In the transition areas between stretchable and reinforced circuit carrier there are donut structures to create a defined transition.
- These transition areas are predefined by regions/shapes.



Source: FlowCAD

OPPORTUNITIES FOR DESIGN-TOOL

Overview of different meander structures



Source: FlowCAD

STRETCH.FLEX

Short survey: with multiple answer options

- **We would like to further develop the technology with our partners. Which tool would you prefer for the next implementation:**

  - Altium
  - Cadence (Allegro / OrCAD)
  - Siemens (Pads / Expedition)
  - Zuken
  - others

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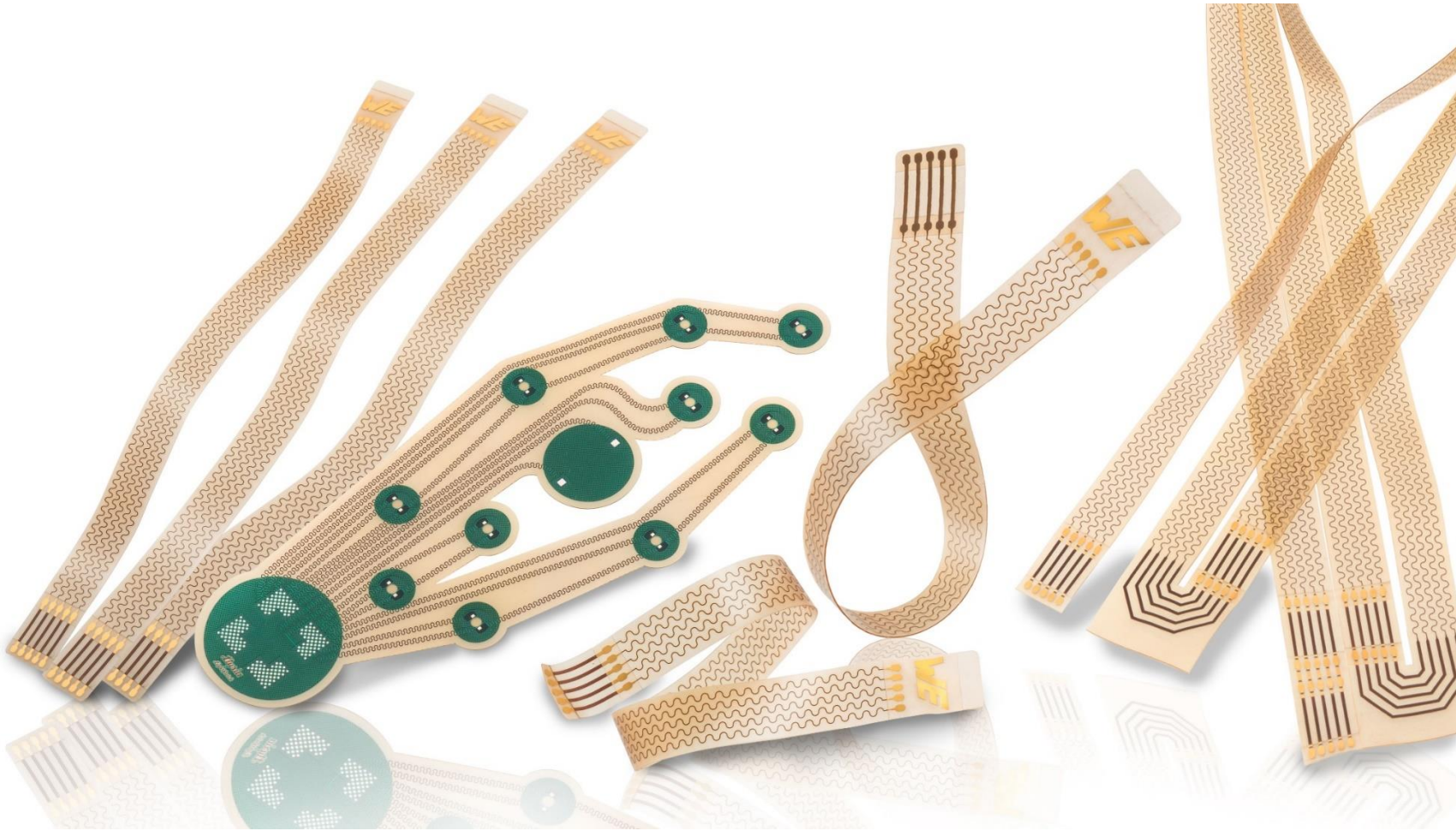
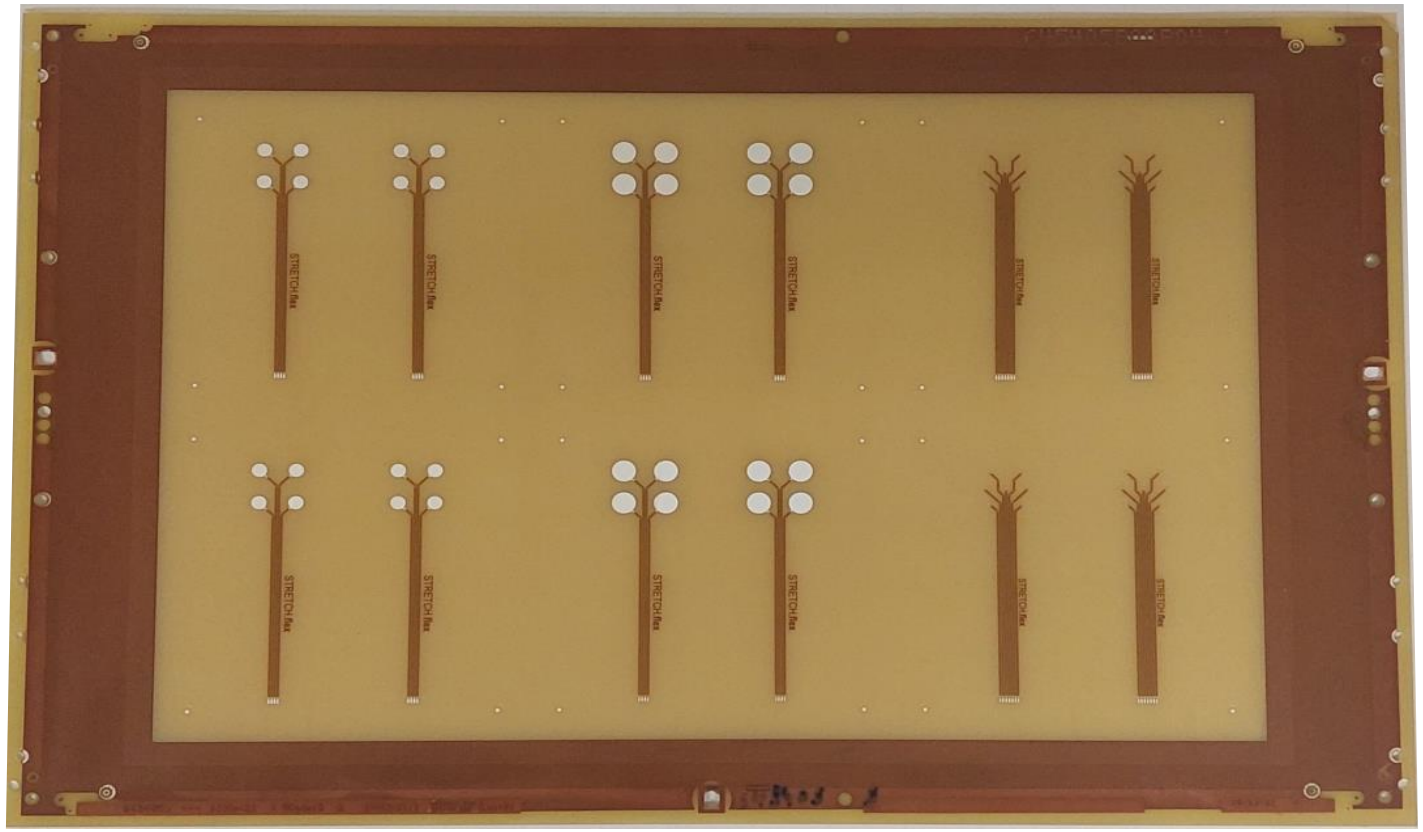


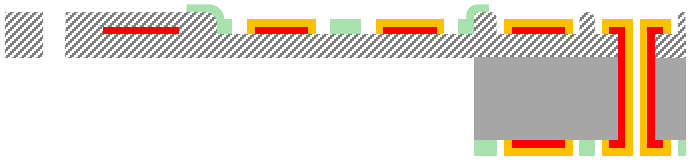
Solder carrier, soldering process (low-melting alloy)

- for transport through the soldering oven, the polyurethane circuit carrier must be reinforced by a support material

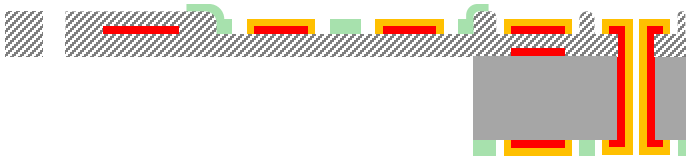


PASTE APPLICATION - STENCIL

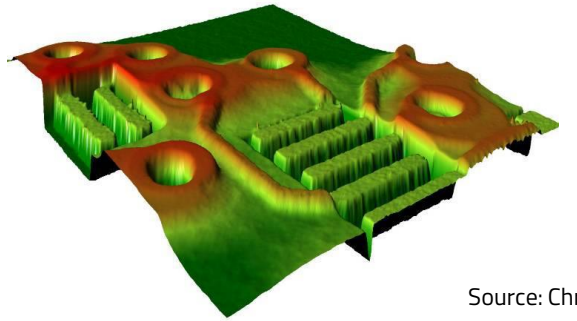
- 1S-1Ri



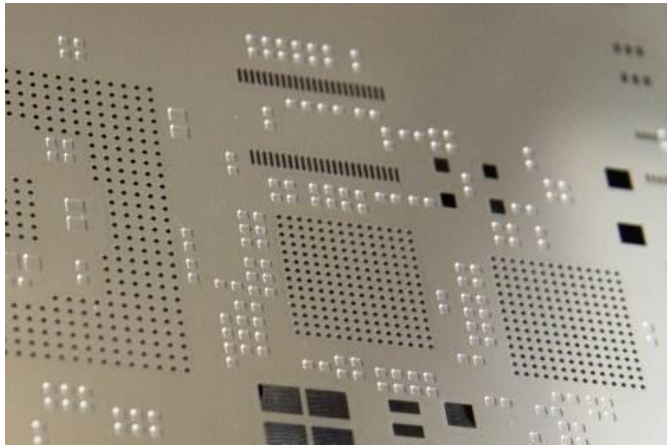
- 1S-2Ri



- possible challenges may be the above-average height differences when using use of additive solder resist can be
- in combination with miniaturized components, e.g. ≤ IPC 0201, the bulges on the top side of the PCB, or bottom side of the paste stencil must be compensated.
  - this can be achieved by cavities on the bottom side of the paste stencil - ask the stencil manufacturer for minimum milling diameter!
  - thus an optimal sealing towards the PCB can be achieved.



Source: Christian Koenen GmbH



Assembly process

- Lowering the process temperature by adding bismuth to the alloy

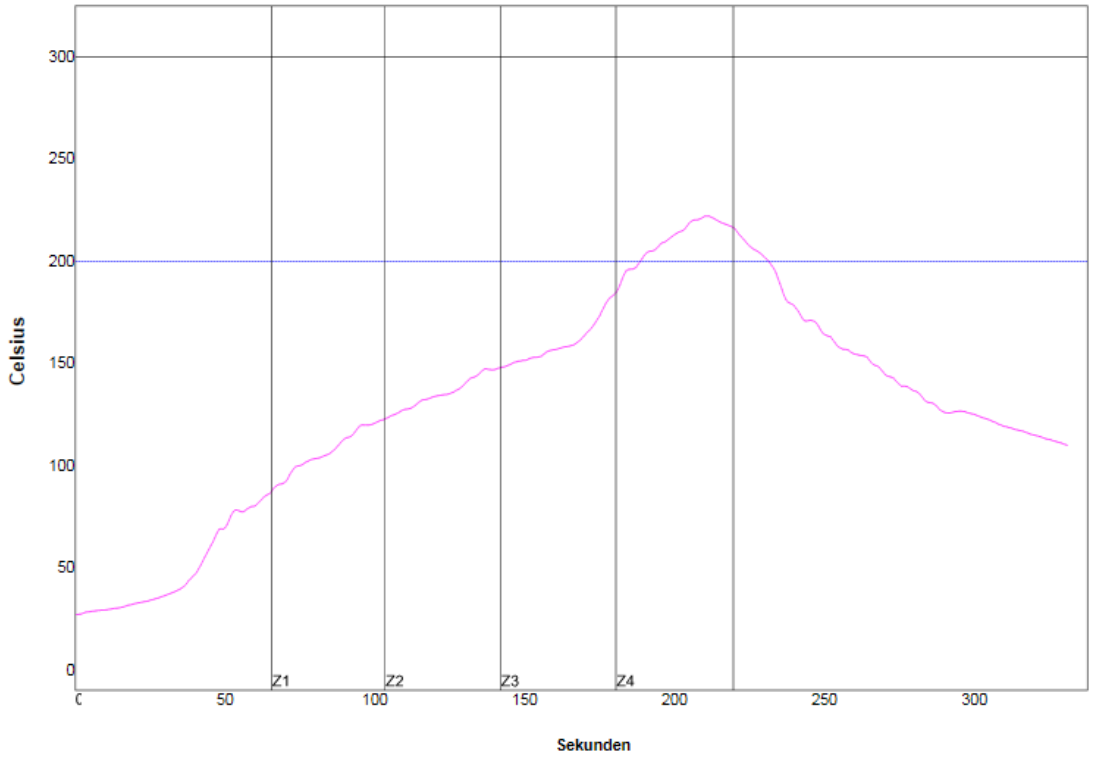
SnBi28:

Schmelzbereich →139°-191°C

Keine Ausdehnung beim Erstarren

Reflowprofil im Peak:

SnBi28>210°C



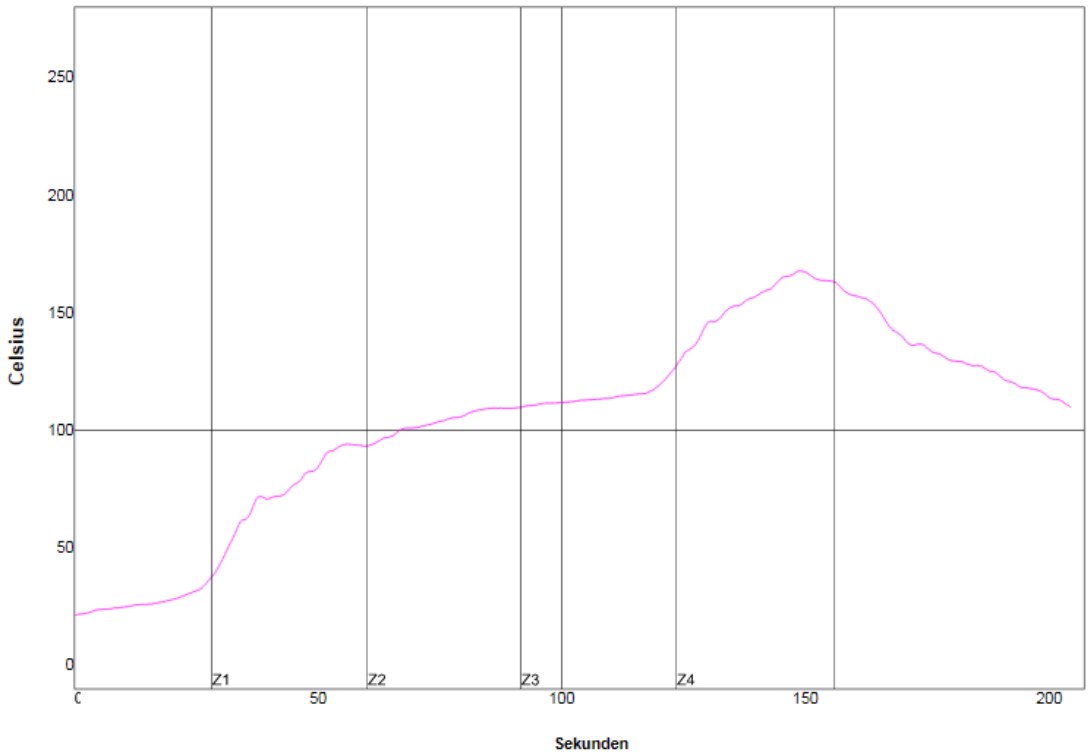
BiSn42Ag0.4 (BSA04):

Schmelzbereich →138°-142°C

Ausdehnung beim Erstarren

Reflowprofilim Peak:

SnBi42Ag0.4 (BSA04) >155°C

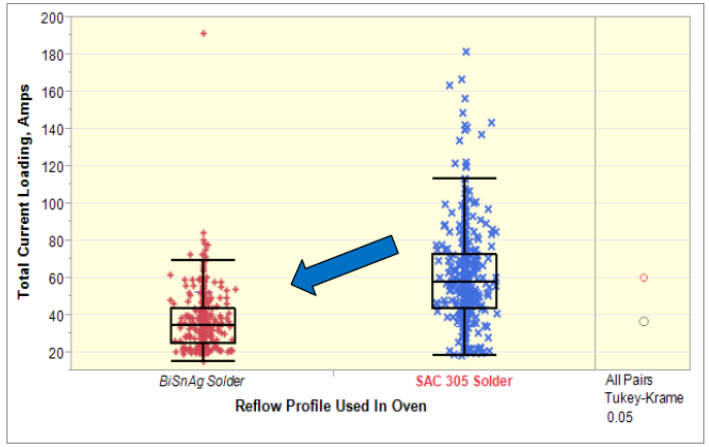


Source: Balver Zinn
Josef Jost GmbH & Co. KG

Conserving resources

- Due to the significantly reduced process temperature, up to 40% of the electrical energy can be saved.
- Compared to a SAC 305 solder paste, the use of tin-bismuth alloys can reduce CO2 emissions per furnace by almost 57 tons.

Cost Saving: Reduced Electricity Consumption



40% Reduction in Electricity Consumption

Measured Parameter	SAC Reflow	BiSnAg Reflow
Current (RMS), amps	60.4	36.7
Power (Average), Kilowatts	29.3	17.8

LTS vs. SAC Reflow Electrical Usage

Estimated SMT Process Energy Cost Comparison			
SAC 305 Paste		Sn/Bi/Ag Paste	
Oven Energy Consumption (Kw)	29.5	Oven Energy Consumption (Kw)	17.8
80% Utilization (Hours/Wk)	134.4	80% Utillzation (Hours/Wk)	134.4
CO2 Metric ton p/kwh (EPA est)*	0.0007		0.0007
CO2 emission per month	2.78		1.67
CO2 Savings (metric tons per oven/week)			**1.1**
CO2 Savings (metric tons per oven/yr)			**57.2**

STRETCH.FLEX

Short survey: multiple choice with only one correct answer

Is this a technology that is of interest to you?

- Yes, I already have a project.
- Yes, but only in one - two years.
- Yes, but not for another five years.
- No.

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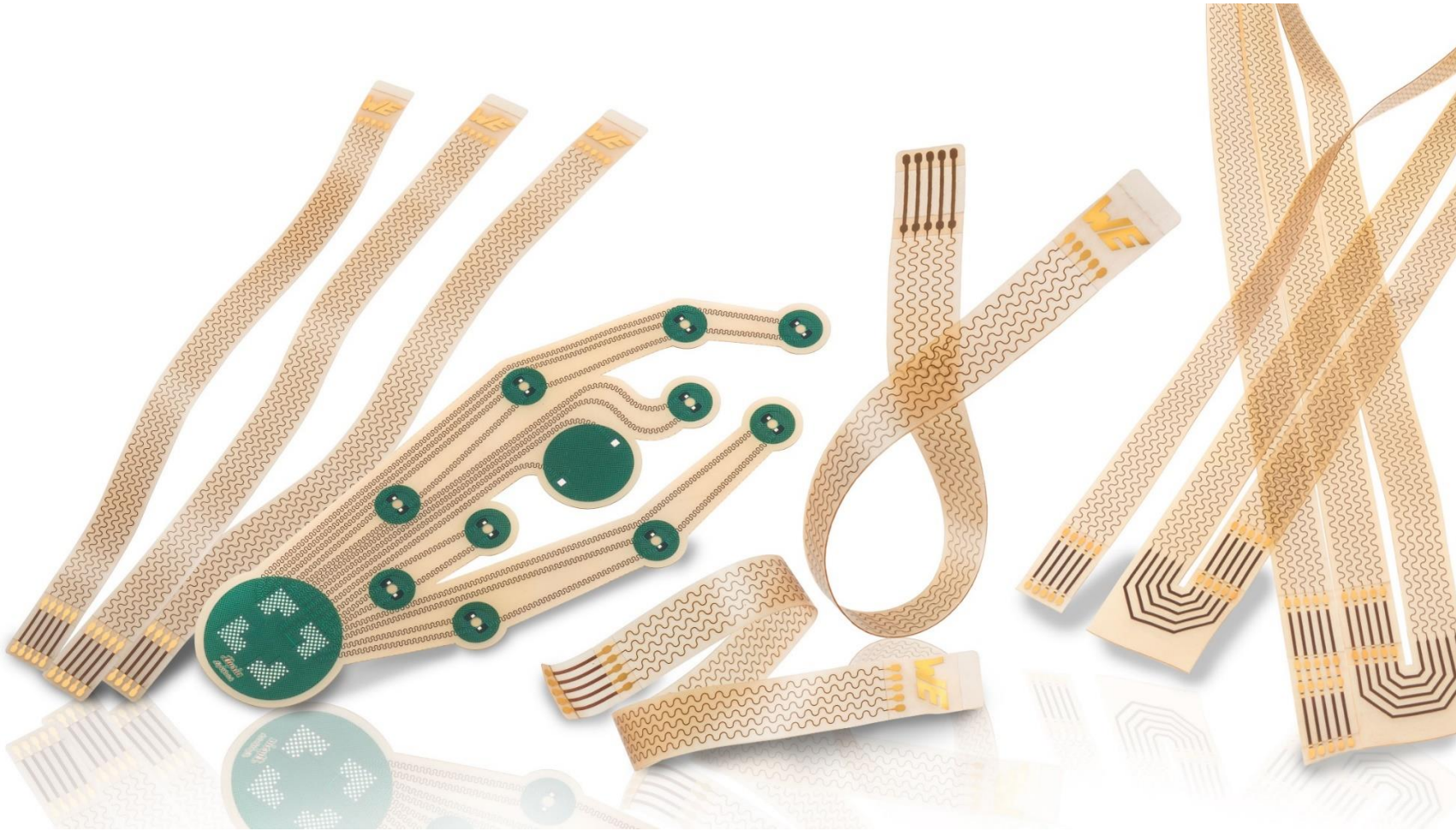


APPLICATIONS

Medical Technology

Sentec Co. – Neonatology Belt

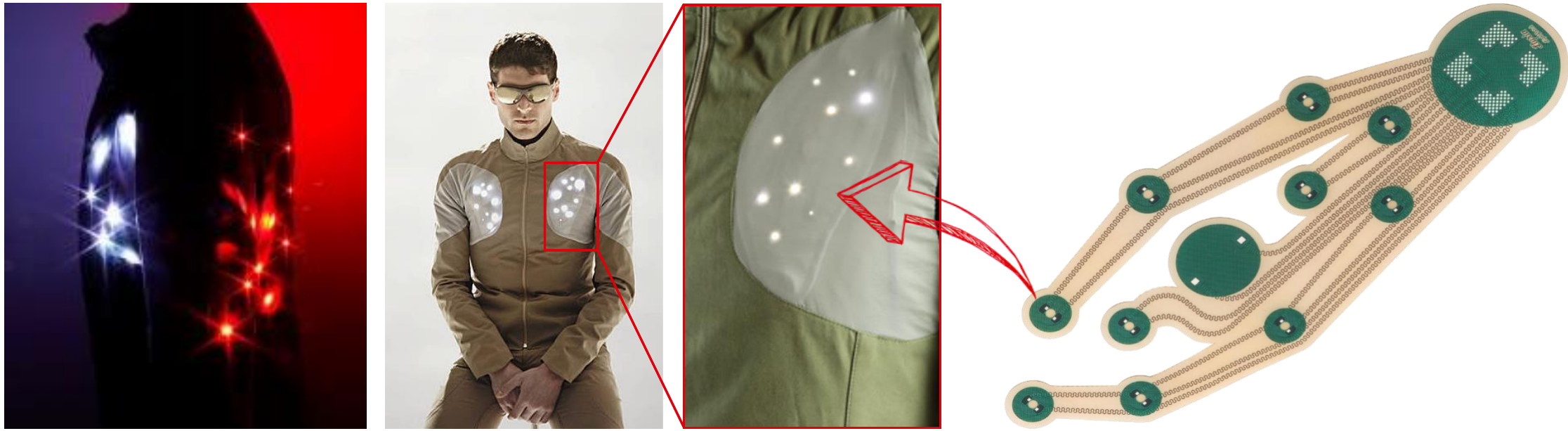
- Treatment of new-borns and premature babies (neonatology)
- Chest strap to directly monitor the lung and heart function through electrical impedance tomography (EIT)
- Advantage against previous solution: Significantly reduced risk of injury to the sensitive skin

APPLICATIONS

Smart Textiles / Wearable Technology

Fraunhofer IZM and Designer Wolfgang Langeder (Utope Co.) / Cycling Jacket „Sporty Supaheroe“

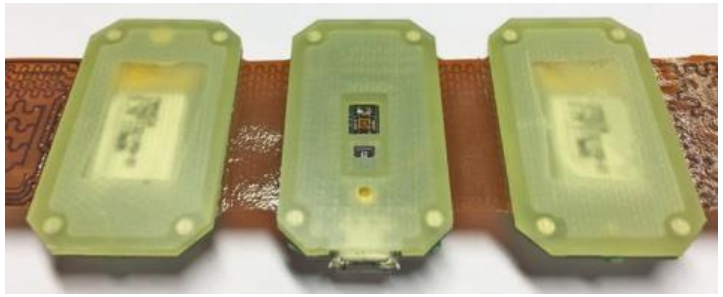
- Integrated and active sensor-controlled LEDs for an interactive safety lighting
- Red Dot Design Award „Design Concept“

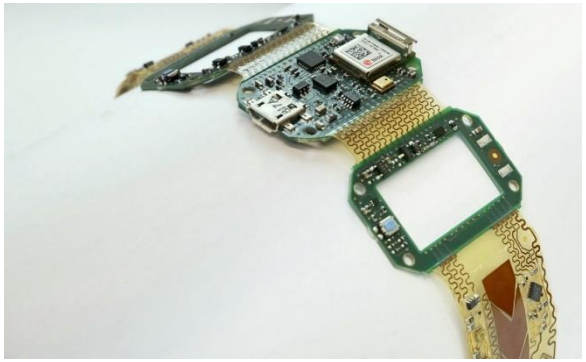


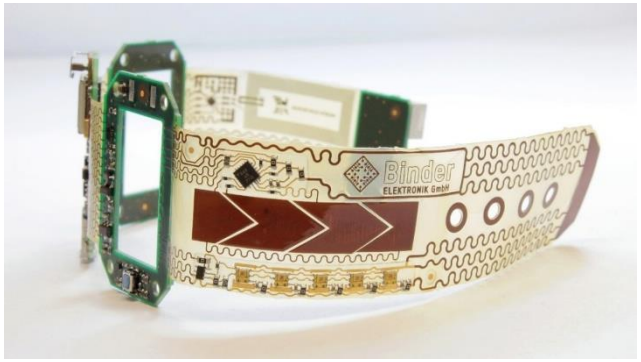
APPLICATIONS

Medical Technology

- **Fa. Binder Elektronik – sensor device close to the body**
  - Monitoring of Dementia patients
  - Band for automatic recording of health and care data
  - Advantage against previous solution: functionalization of the complete band



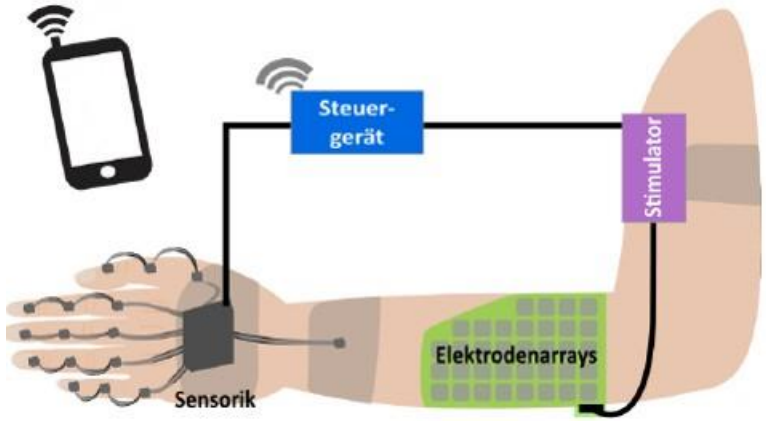


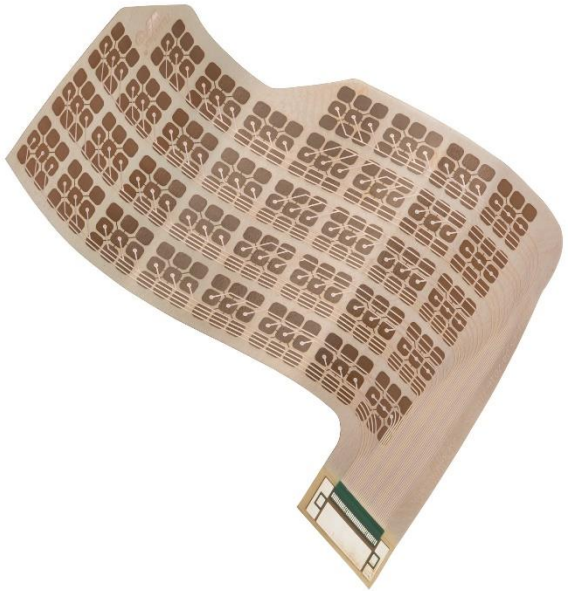


APPLICATIONS

Medical Technology

- **Electrode arrays for EMD application**
  - Rehabilitation of stroke patients using electrical muscle stimulation
  - Stimulation of muscle parts via single or multiple elements to regain autonomous movement ability



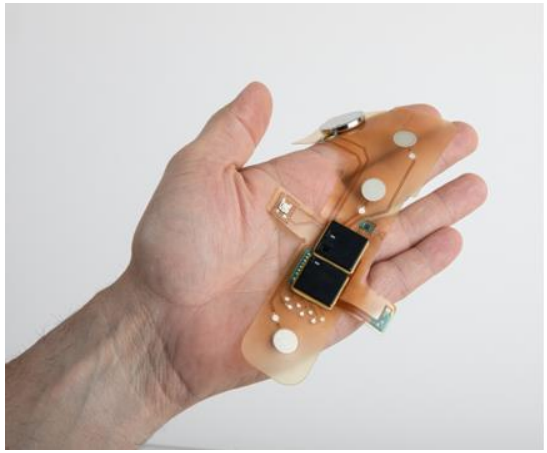


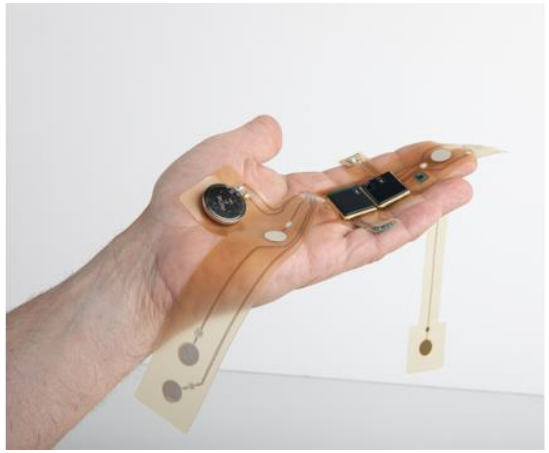
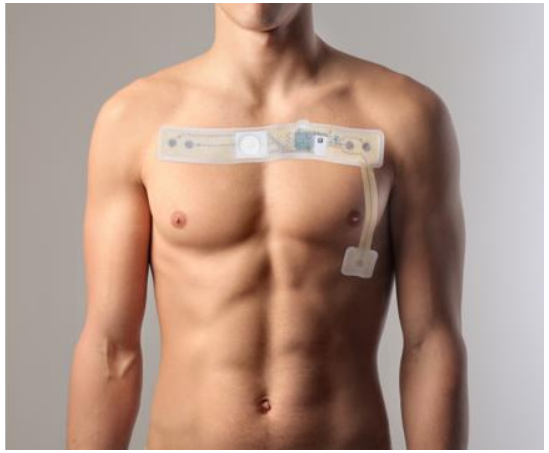
APPLICATIONS

APPLAUSE

Medical Technology

- **Multimodal monitoring concept with wearable patch**
  - ECG, skin temperature, Impedance pneumography as well as photoplethysmography (PPG) measurments
  - High degree of miniaturization and dense integration results in a inconspicuous shape
  - The use of TPU has increased the wearing comfort



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ECSEL JU

APPLAUSE

THANKS FOR YOUR ATTENTION!

What kind of application do you have?
How can WE support you?

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