Investigation on the Use of the PE873 Conductive Ink for Surface EMG Measurements

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Why look for new ways to make connections?

So far electric cables represent the best connection we can have in terms of reliability and resistivity.

Why look for new ways to make connections?

On the other hand, the presence of cables on wearable devices makes movements difficult and is really annoying.

Why look for new ways to make connections?

A

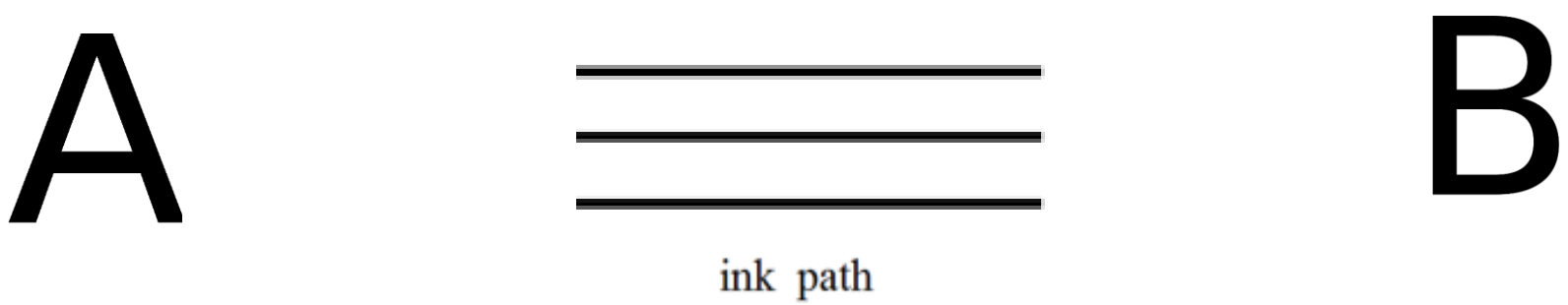
B

The ideal solution would consist in being able to connect two points, A and B, by replacing conventional wires with reliable and more “user friendly” materials.

Why look for new ways to make connections?

Among the possible solutions, conductive inks represent a very interesting option due to their stretching and washing suitability.

Why look for new ways to make connections?



Materials and Method

Overall system

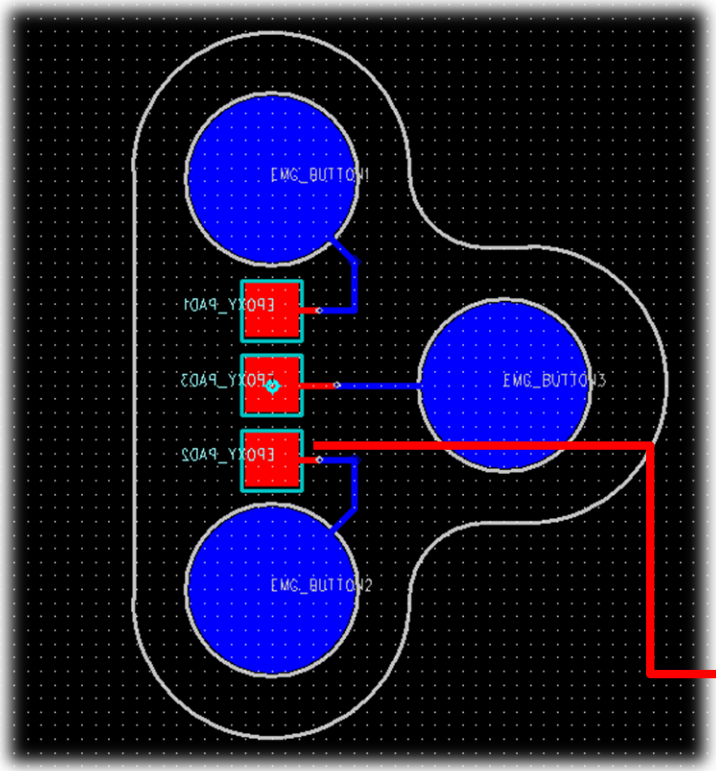
electrode

ink path

In this research the conductive ink is used to create an electrical connection on a strip of fabric between a conductive electrode (point A) and an EMG measuring device (point B).

Materials and Method

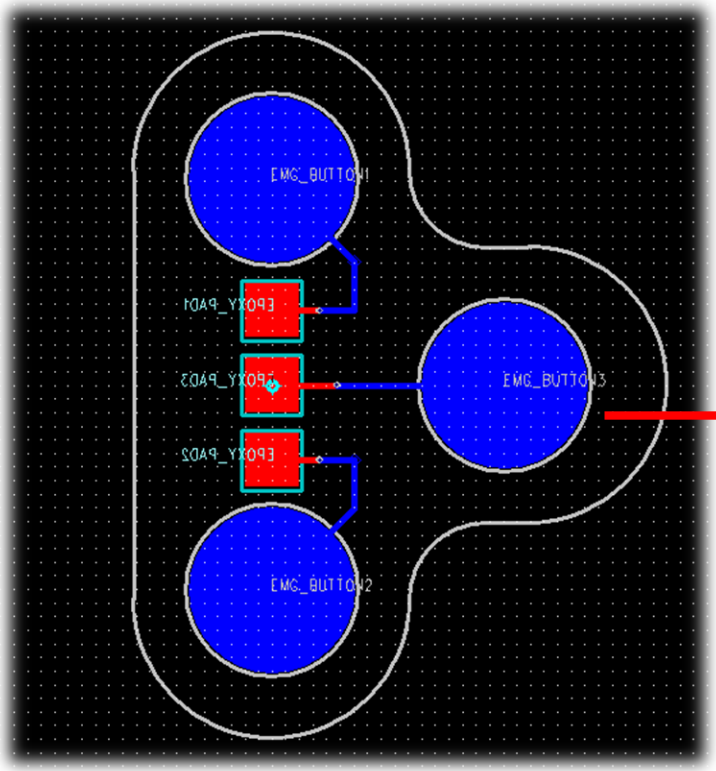
Signal capture and communication



A custom PCB is designed.
Its 3 bottom pads are glued to the ink paths by conductive epoxy to ensure electric connection.

Materials and Method

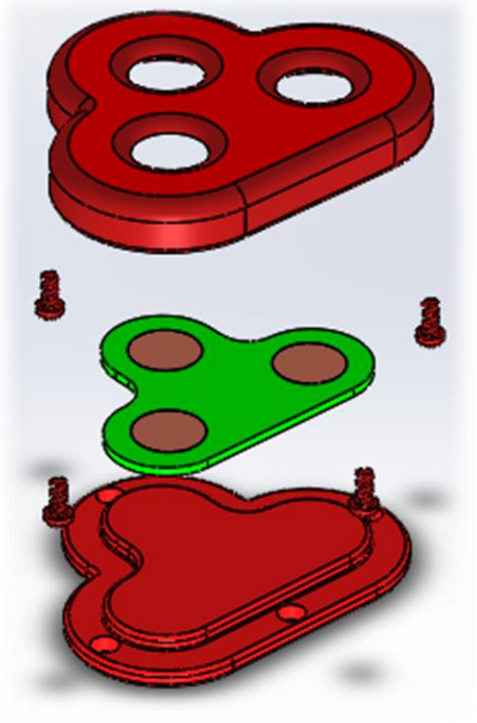
Signal capture and communication



The 3 top pads are soldered to snap buttons so as to connect the EMG measuring device.

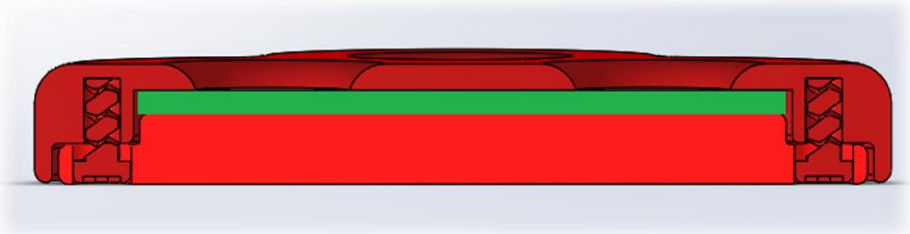
Materials and Method

Signal capture and communication



3D mechanical support

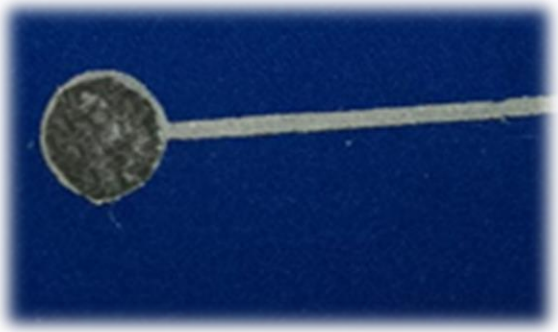
To avoid every movement a mechanical support has been created by 3D printing.



3D mechanical support (section)

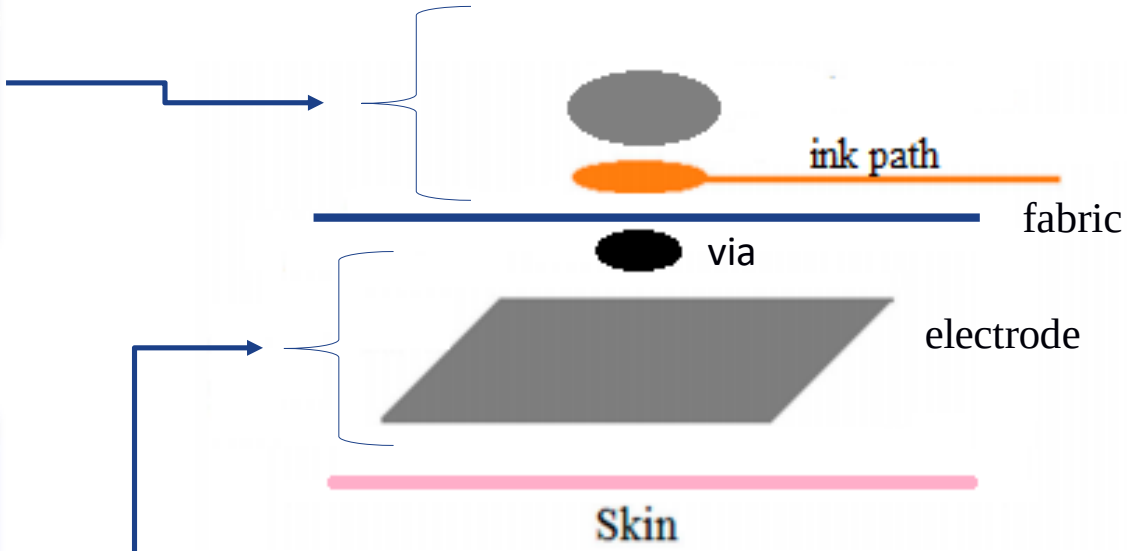
Materials and Method

Signal capture and communication



Top fabric

Bottom fabric



Materials and Method

Printing Process

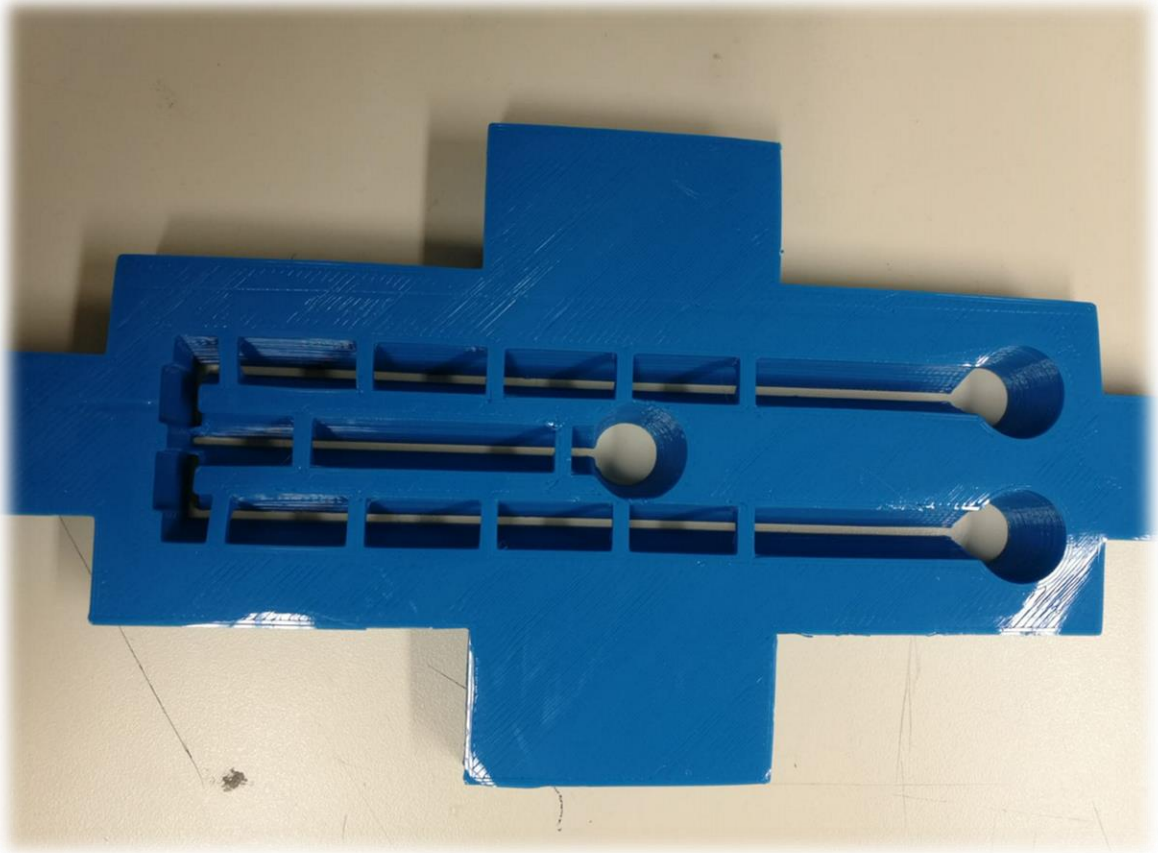
Silk-screen printing is one of the most popular printing techniques.
Art sector and textile printing use serigraphy.
Serigraphy uses:

- screen: made by a piece of mesh stretched.
- ink-blocking stencil.

Materials and Method

Printing Process

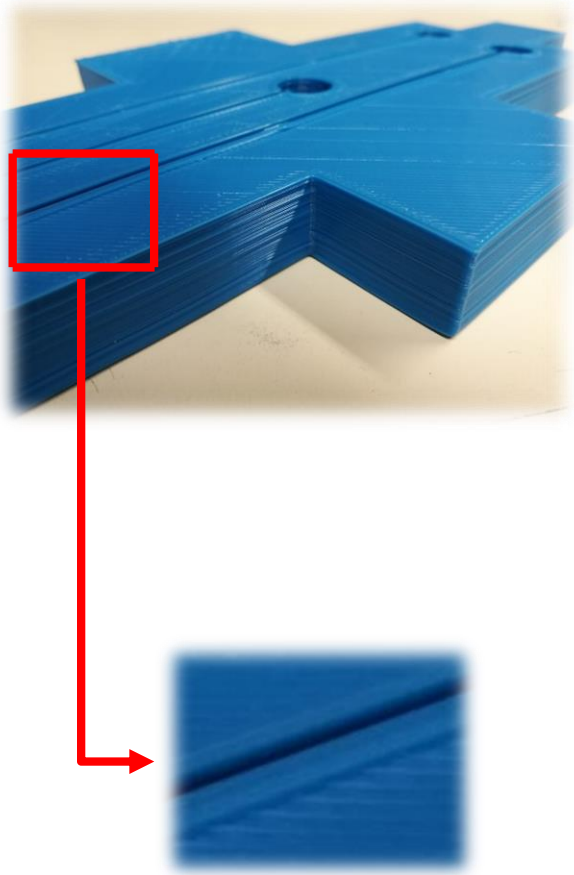
To emulate serigraphy a custom 3D mask is designed to be use as a mould.



Materials and Method

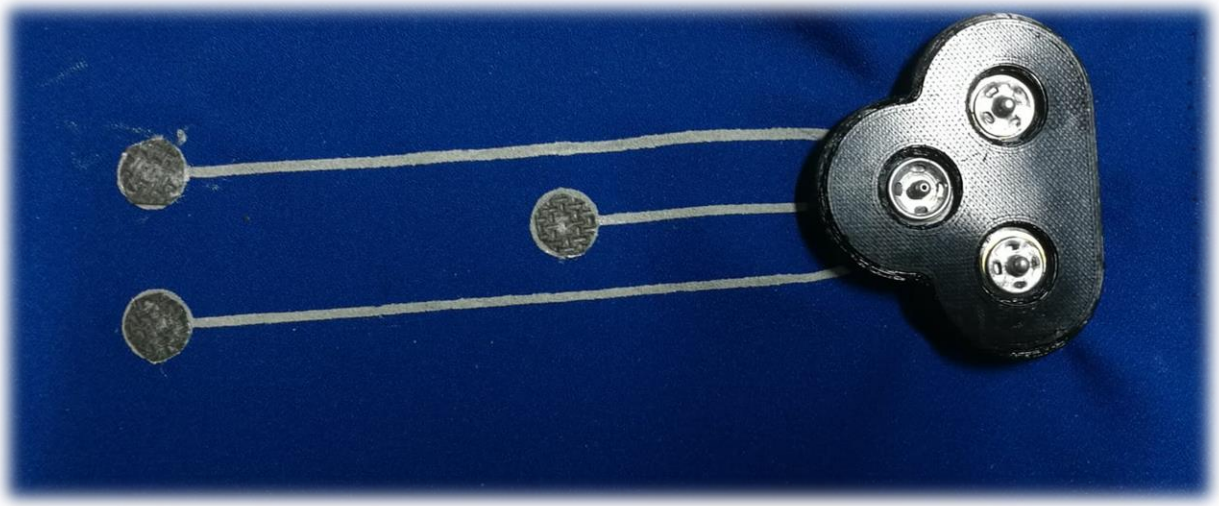
Printing Process

A small step added on the bottom face of the mould, allows more pressure on the fabric surface in order to avoid possible leakage of the ink.

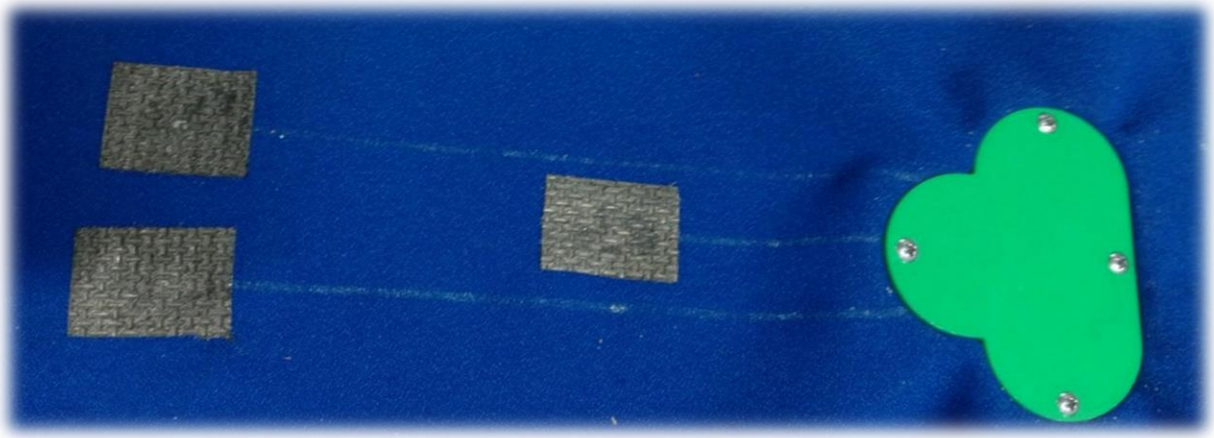


Materials and Method

Printing Process



Top view



Bottom view

Tests and Conclusion

To test the ink behavior, the tests are performed on two types of fabric: unstretchable (blue) and stretchable (black).

Tests and Conclusion

Three tests are performed:

- Stretch Test

- Wash Test

- Fold Test

Tests and Conclusion

During the tests, 10 measurements are taken for each condition.

Data shown in the following graphs illustrates the average of these measurements.

The ink used in the tests is the PE873 made by Dupont.

Tests and Conclusion

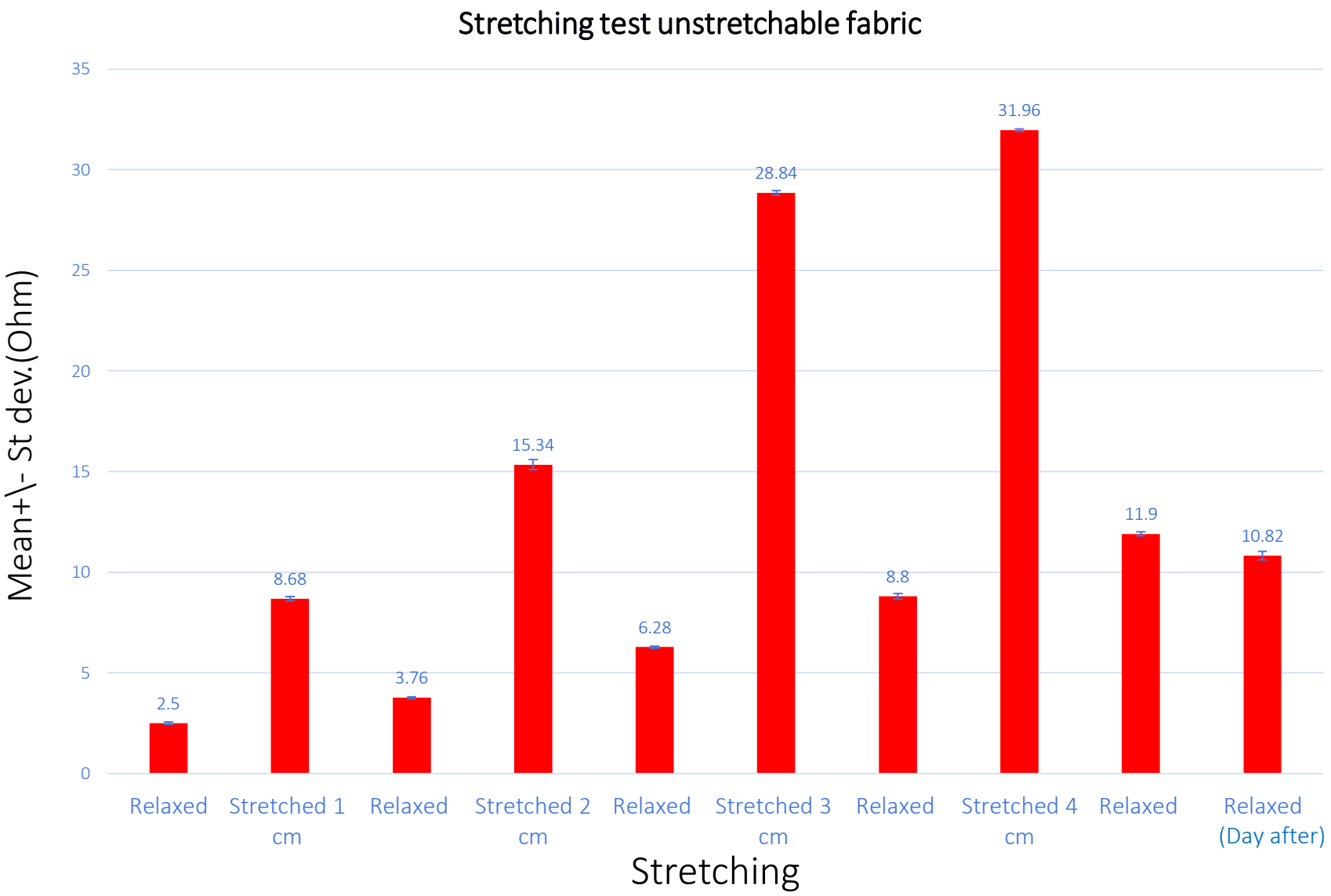
Stretch test

The stretch test consists of three steps:

1. Resistivity measurement in rest position.
2. Resistivity measurement in stretched position.
3. Resistivity measurement in rest position.

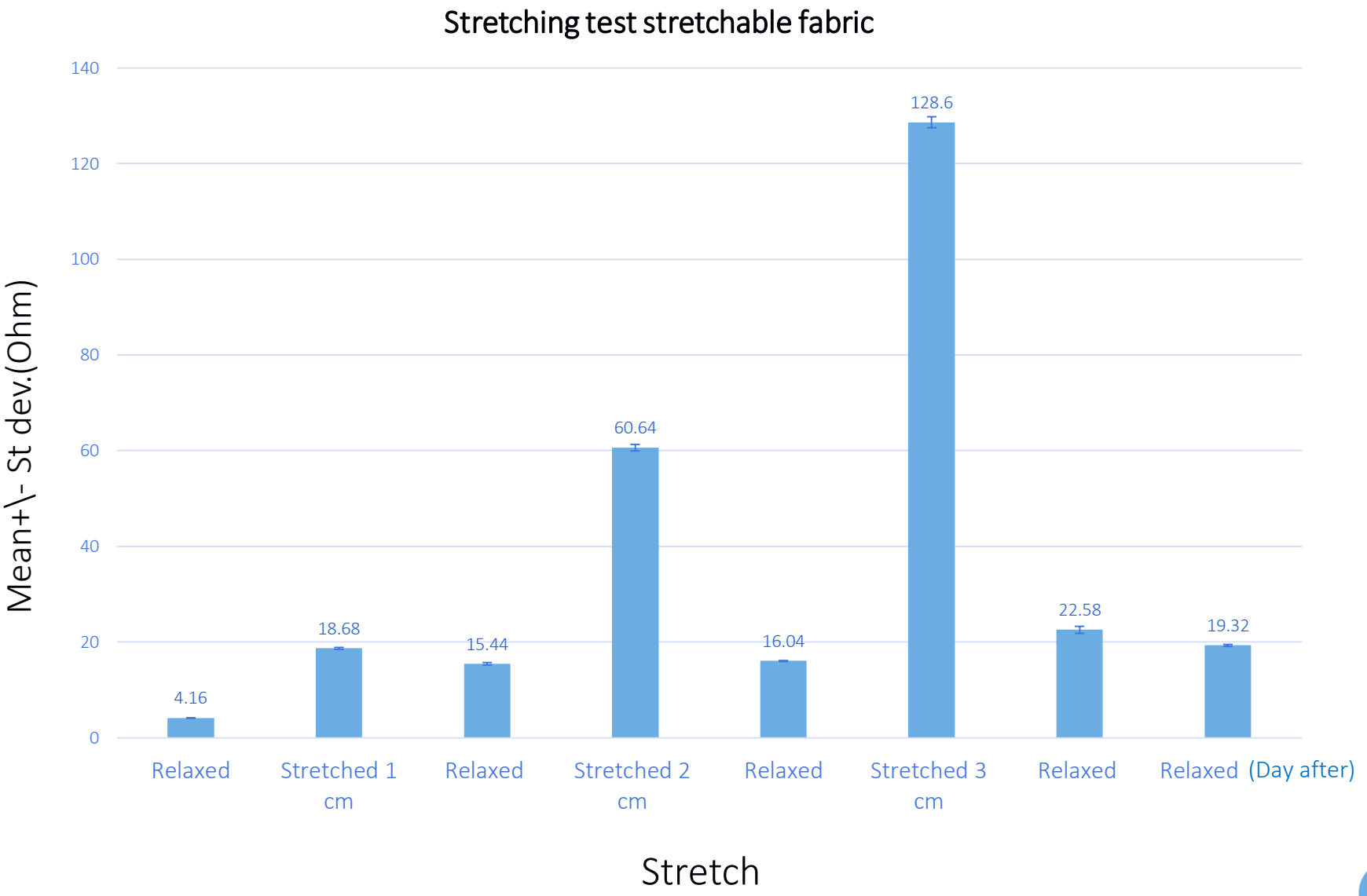
Tests and Conclusion

Stretch test



Tests and Conclusion

Stretch test



Tests and Conclusion

Folding test

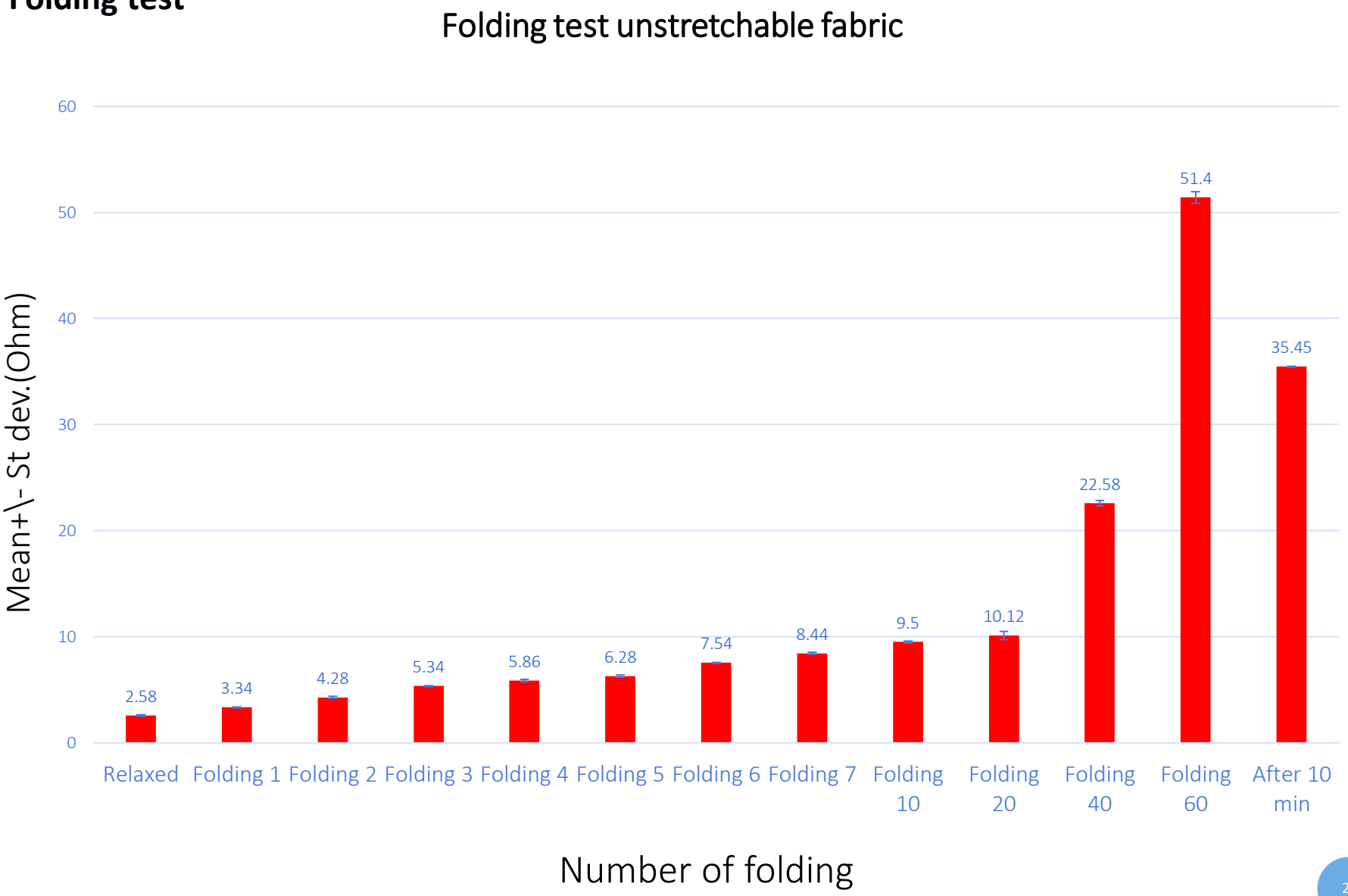
The foldin test consists of two steps:

1. Resistivity measurement in rest position.

2. Resistivity measurement after each folding.

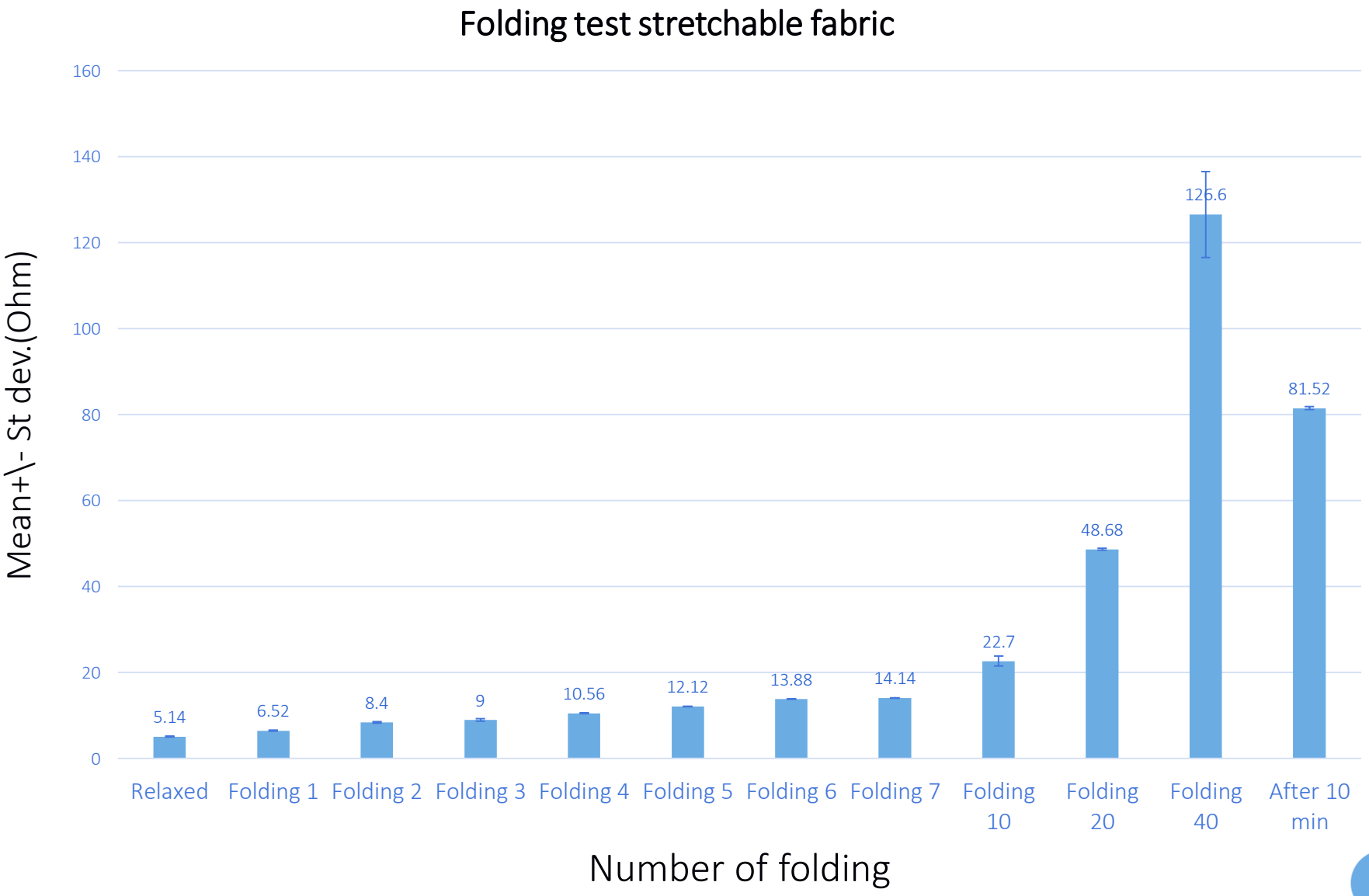
Tests and Conclusion

Folding test



Tests and Conclusion

Folding test



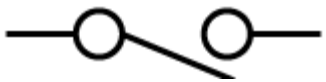
Tests and Conclusion

Wash test

+

30° synthetic

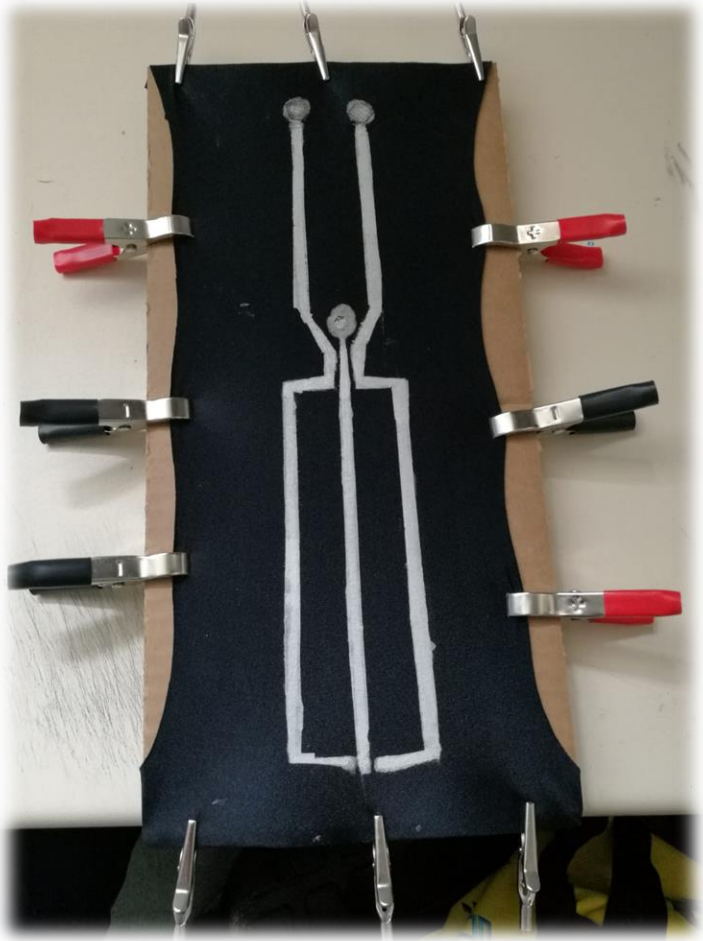
=



After a single wash, the paths is not conductive anymore.

Tests and Conclusion

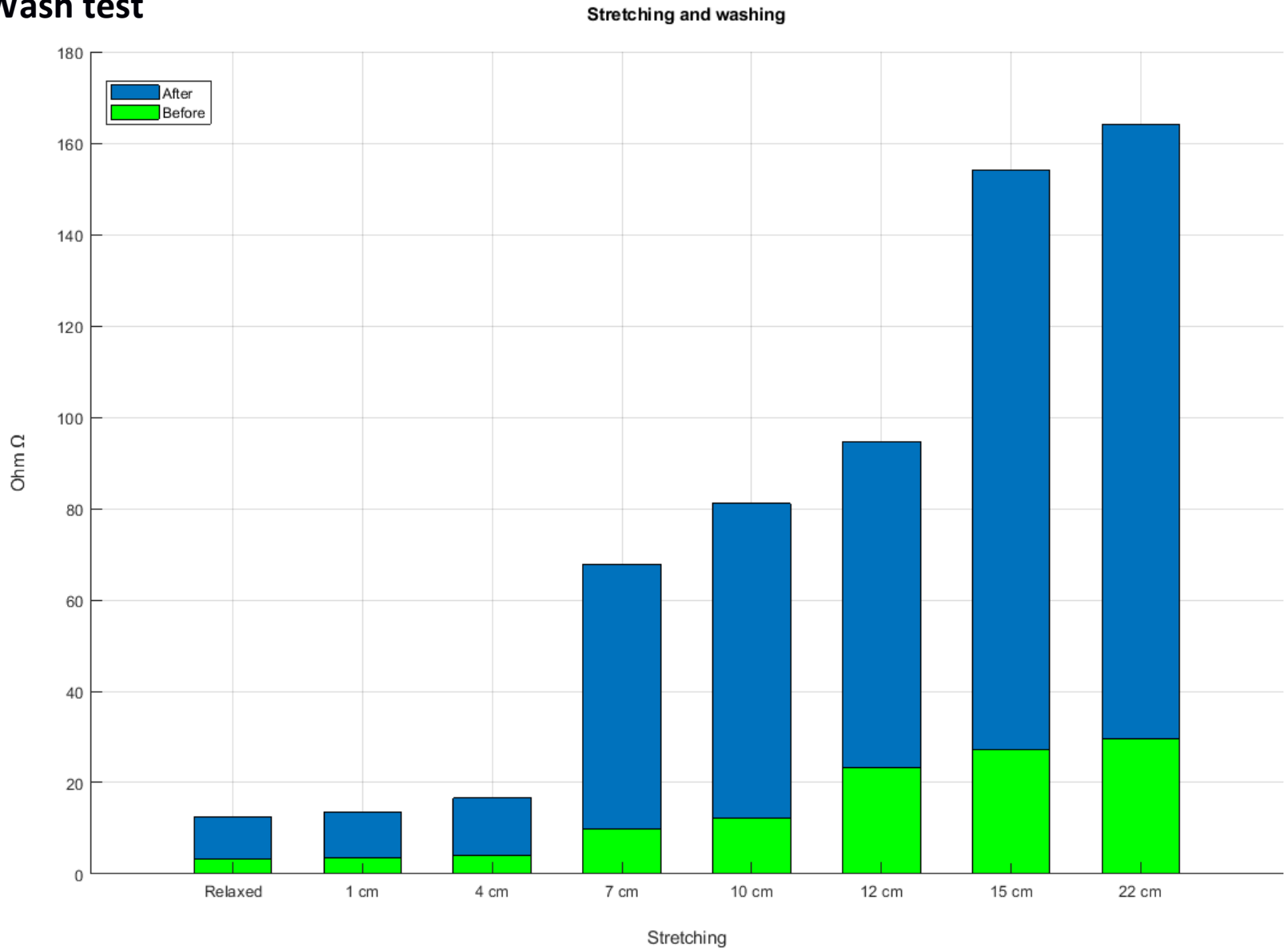
Wash test



As a possible solution, samples with more than one layer of conductive ink (three layers) are created.

Tests and Conclusion

Wash test



Tests and Conclusion

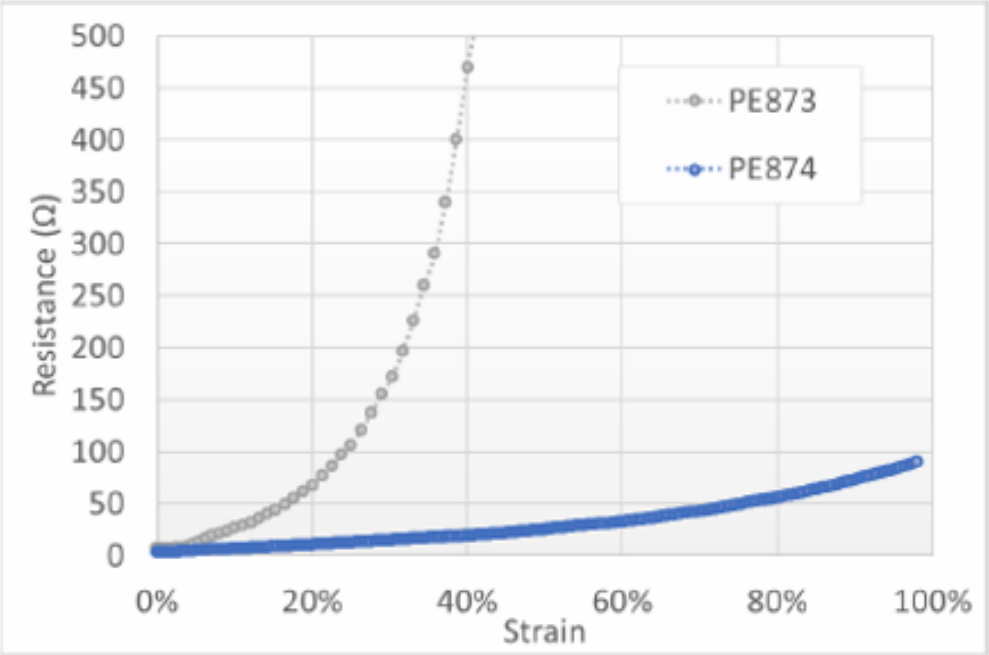
Conclusion

Overall

- The results are satisfactory only in a small range of stresses.
- The ink PE873, printed as sold, is not able to replace cables .

Future developments

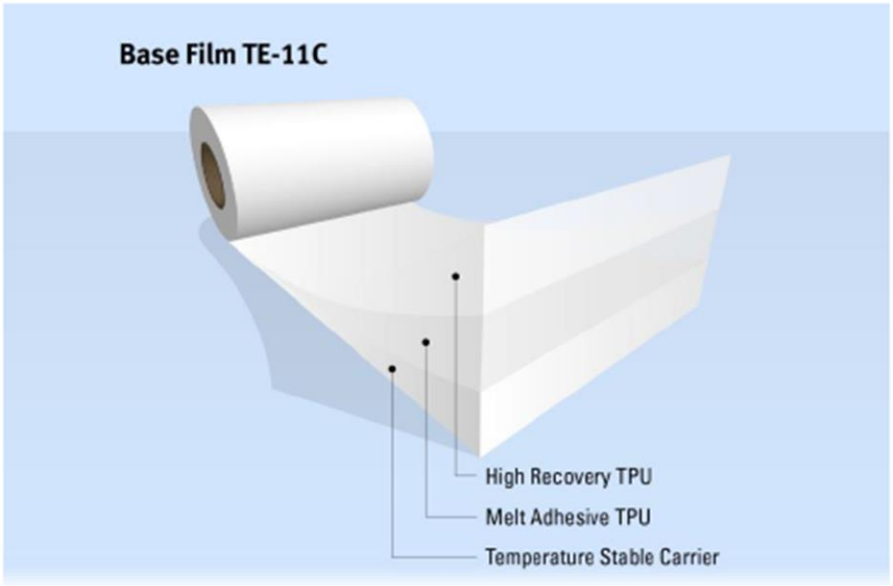
PE874 Mechanical & Electrical Performance



A new generation of conductive ink is now available on the market, promising better performance.

Future developments

Furthermore, stretchable TPU (thermoplastic polyurethane) film can be used as interface layer for enhancing electrical performances and recovery capabilities.



- High recovery layer is designed for stretchable ink printing on top surface.
- Melt adhesive layer is designed for bonding to fabric under heat press lamination.

Thanks

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