

# 3D – Large Scale Integration of Sensors into Smart Textile

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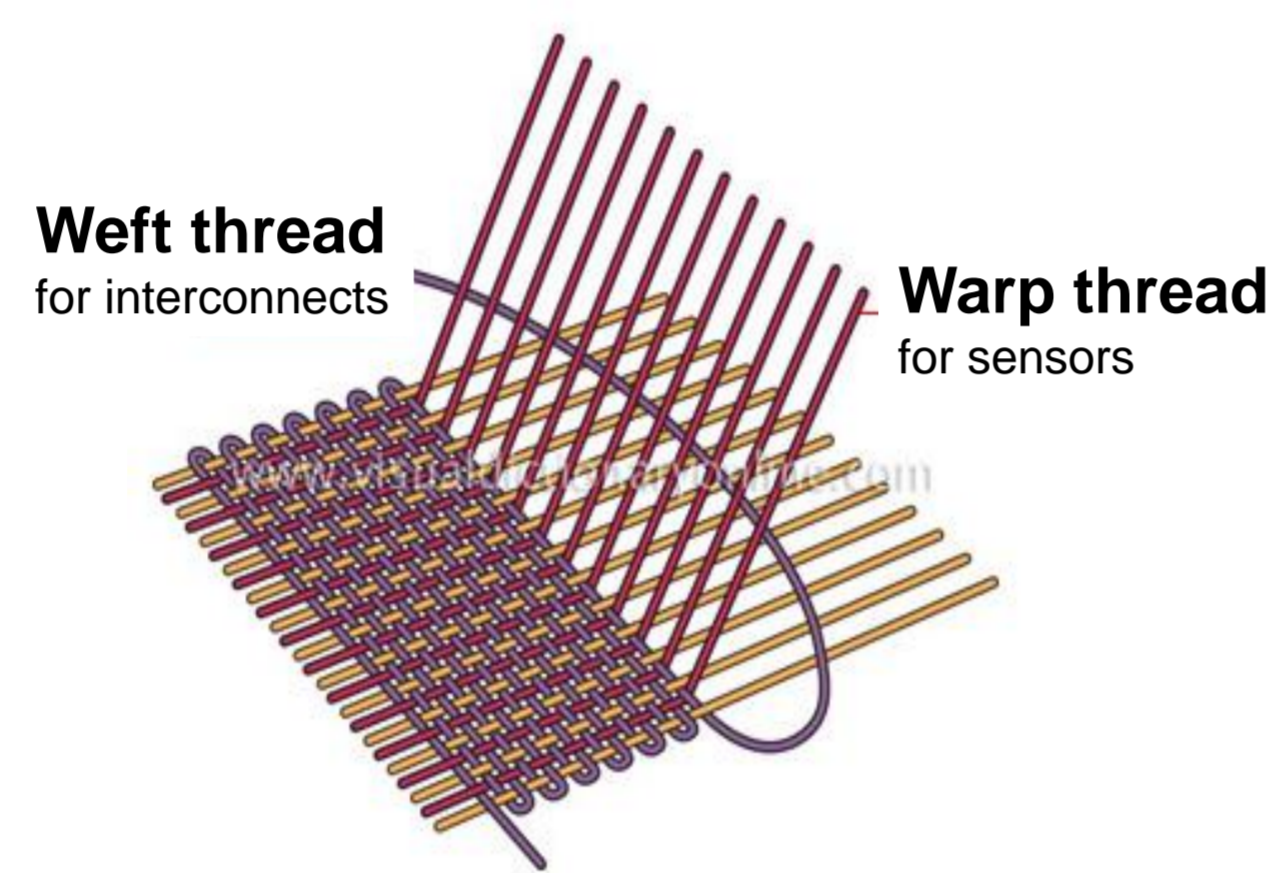


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## Industrial Textiles with electronic components

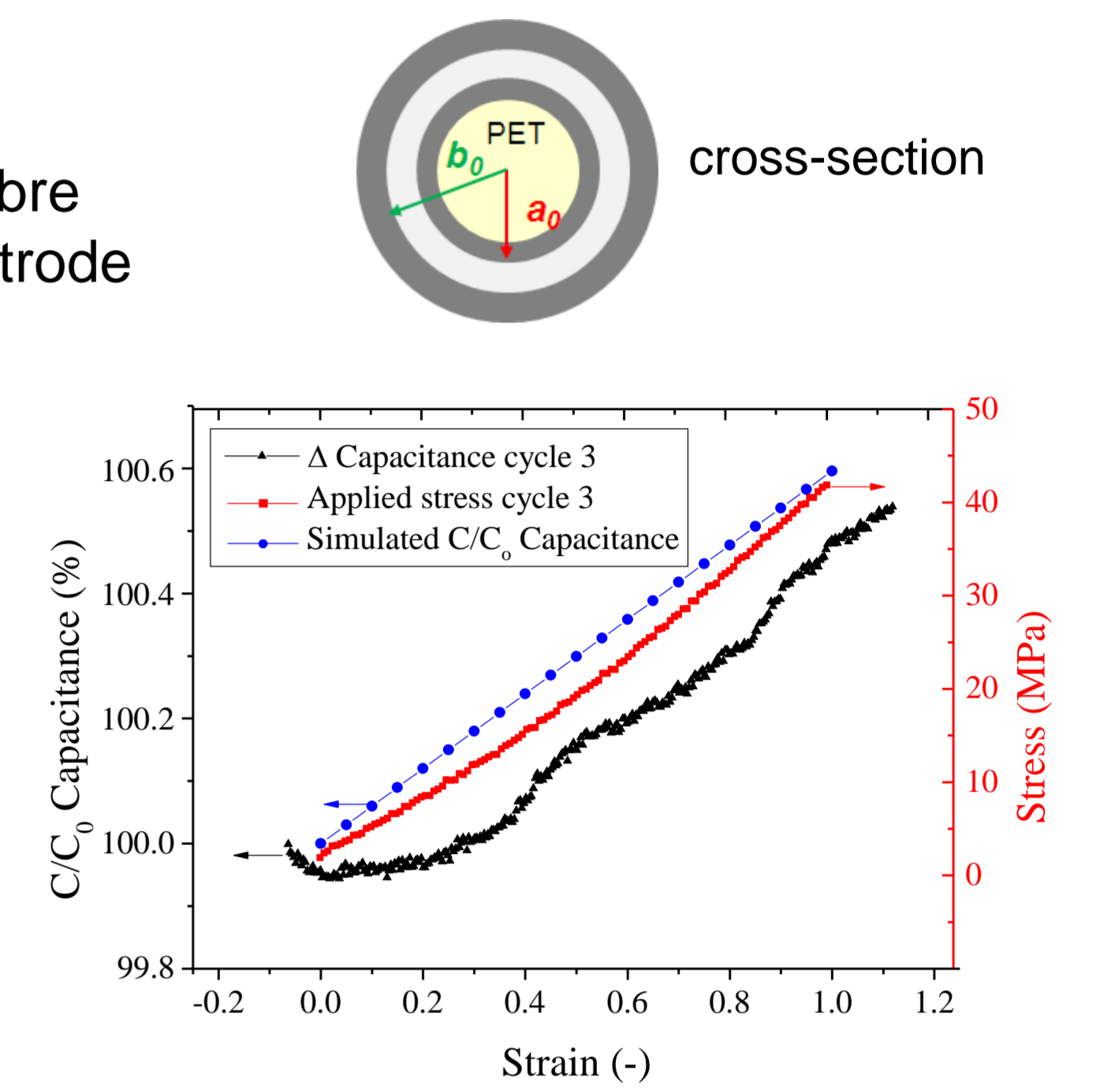
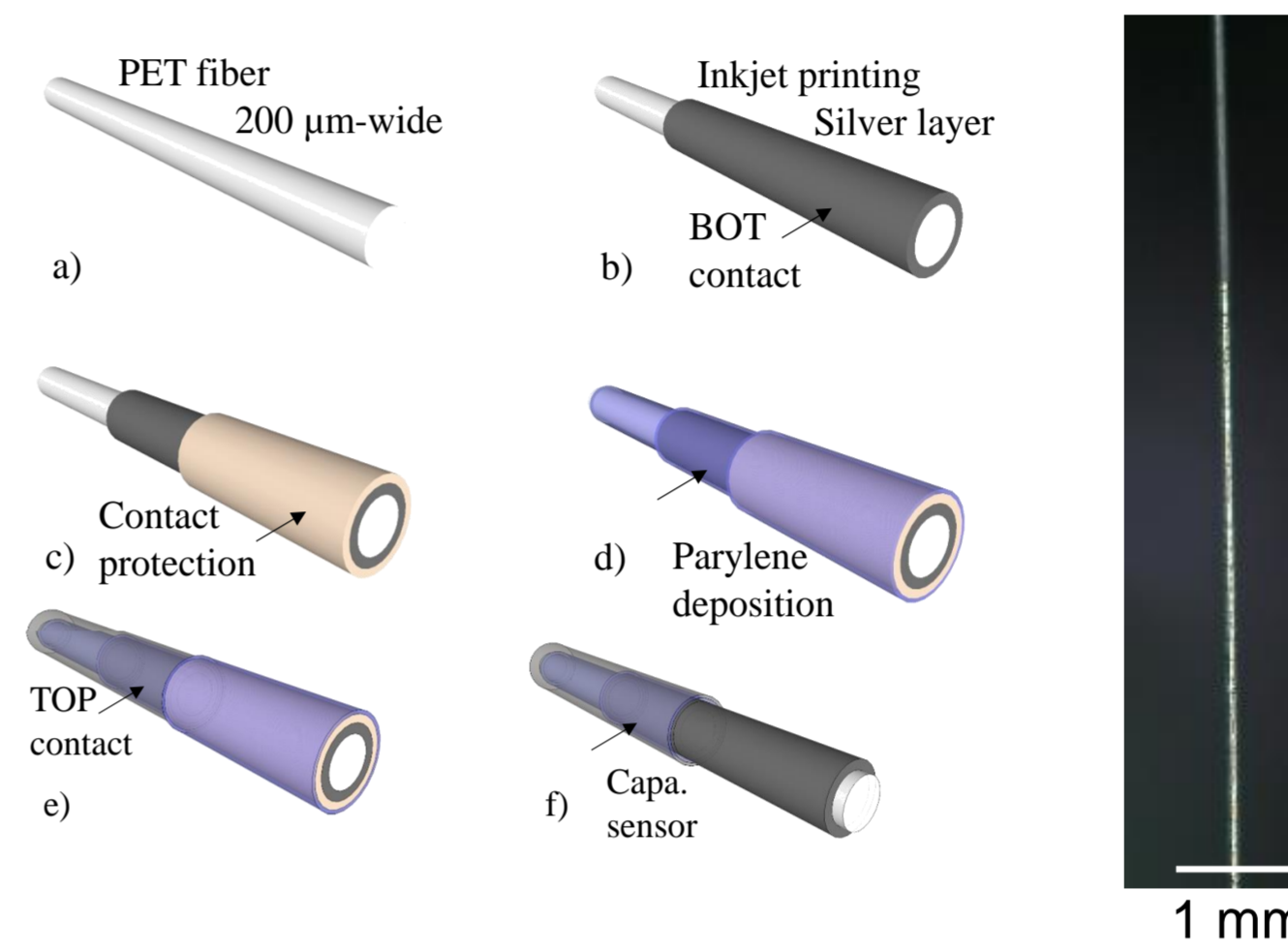
large – area textile for mechanical stimuli detection: sensors and TFTs fabricated on cylindrical fibres either by **cleanroom technology** or by **printing techniques**

- Functionalise 10 meters long fibers
- Weaving of functionalised fibers and their interconnects in industrial machine
  - Alignment procedure
  - Weaving pattern
  - Nature of textile
  - Type of machine
- Perform their electrical interconnections on woven textile



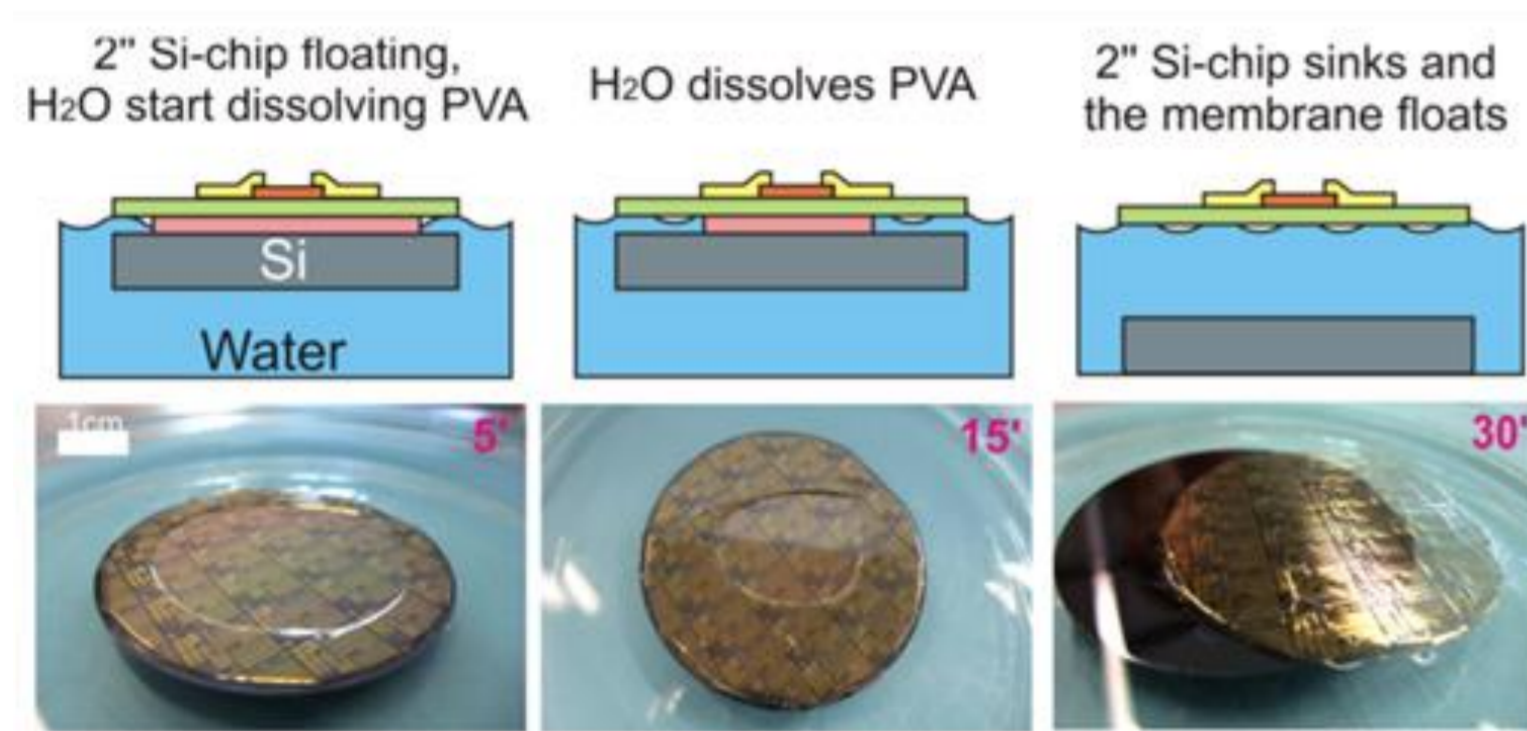
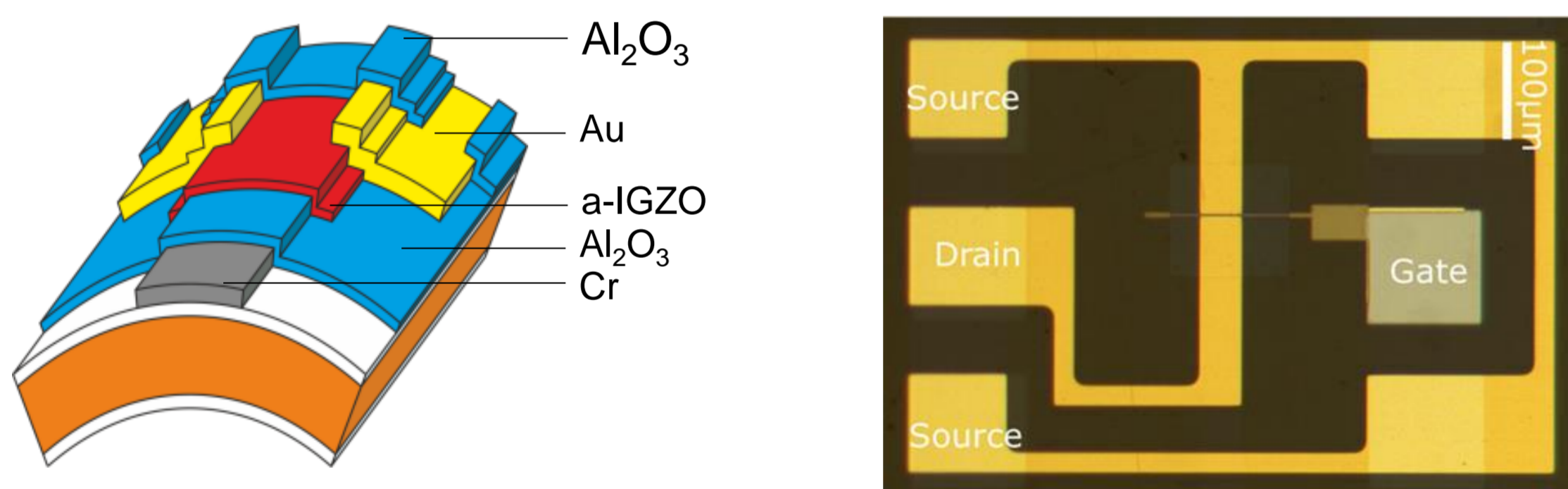
## Inkjet printed capacitive strain sensors

- Substrate:** PET fibres (50 to 200  $\mu\text{m}$ )
- Dielectric:** parylene-C (2  $\mu\text{m}$ )
- Outer electrode:** Ag electrode around the fibre
- Inner electrode (PET core fibres):** Ag electrode

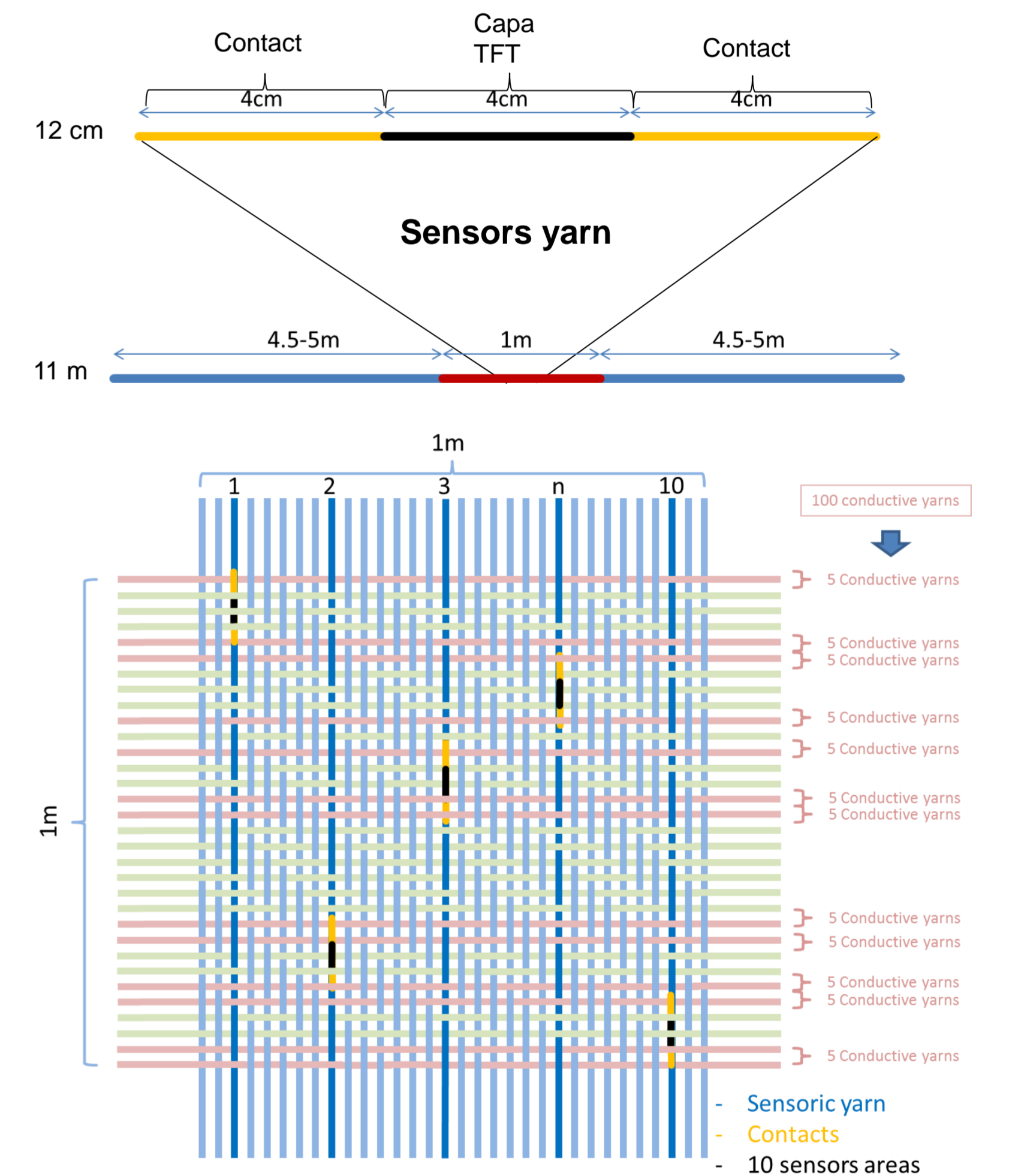


## Thin film transistors

- Substrate:** Polyimide (75  $\mu\text{m}$ )
- Gate dielectric:** ALD  $\text{Al}_2\text{O}_3$
- Semiconductor:** a-IGZO (~ 15 nm)
- Source and drain electrodes:** 10 nm Ti + 60 nm Au
- Gate:** Cr



## Weaving process and electrical connections



- 1 m x 1 m smart textile woven at SEFAR AG**

### Challenges:

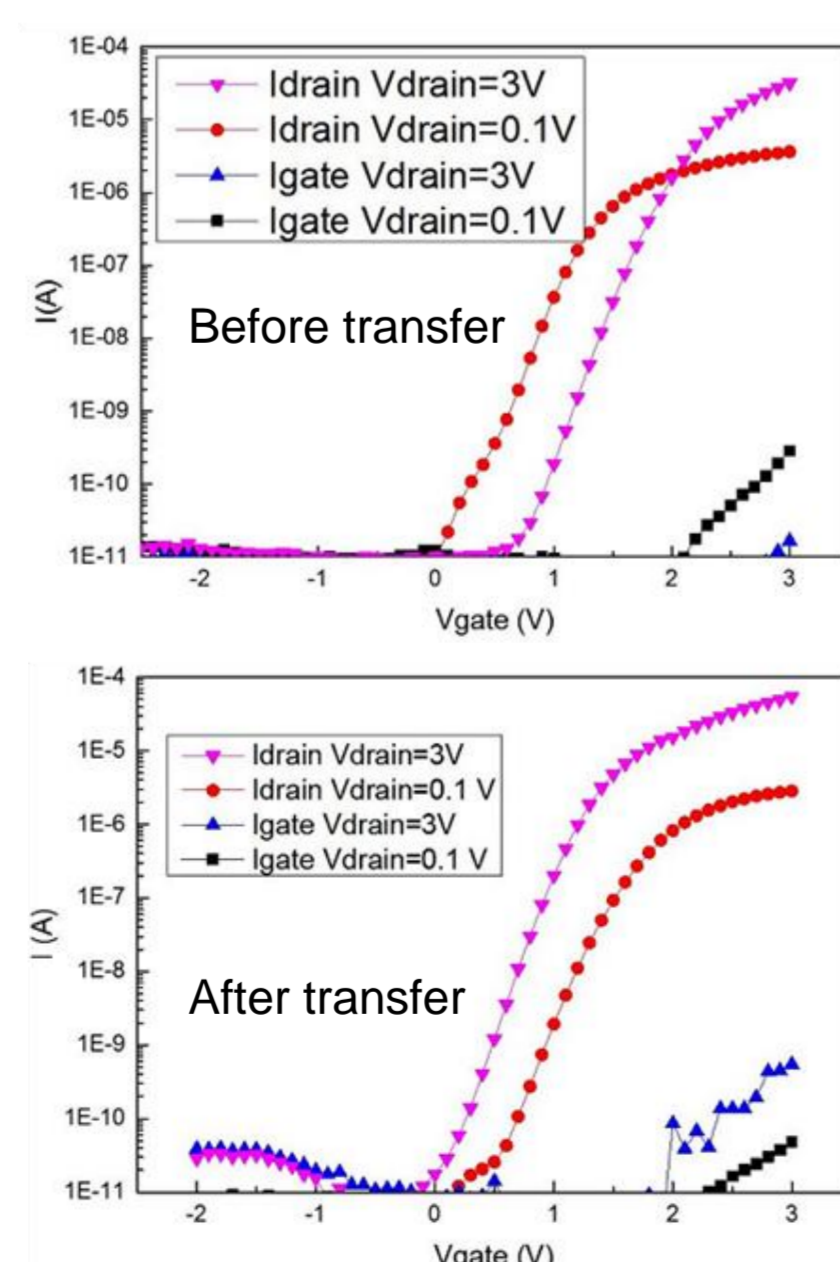
- Mechanical stress
- Mechanical friction
- Small bending radius
- Alignment

## Demonstration

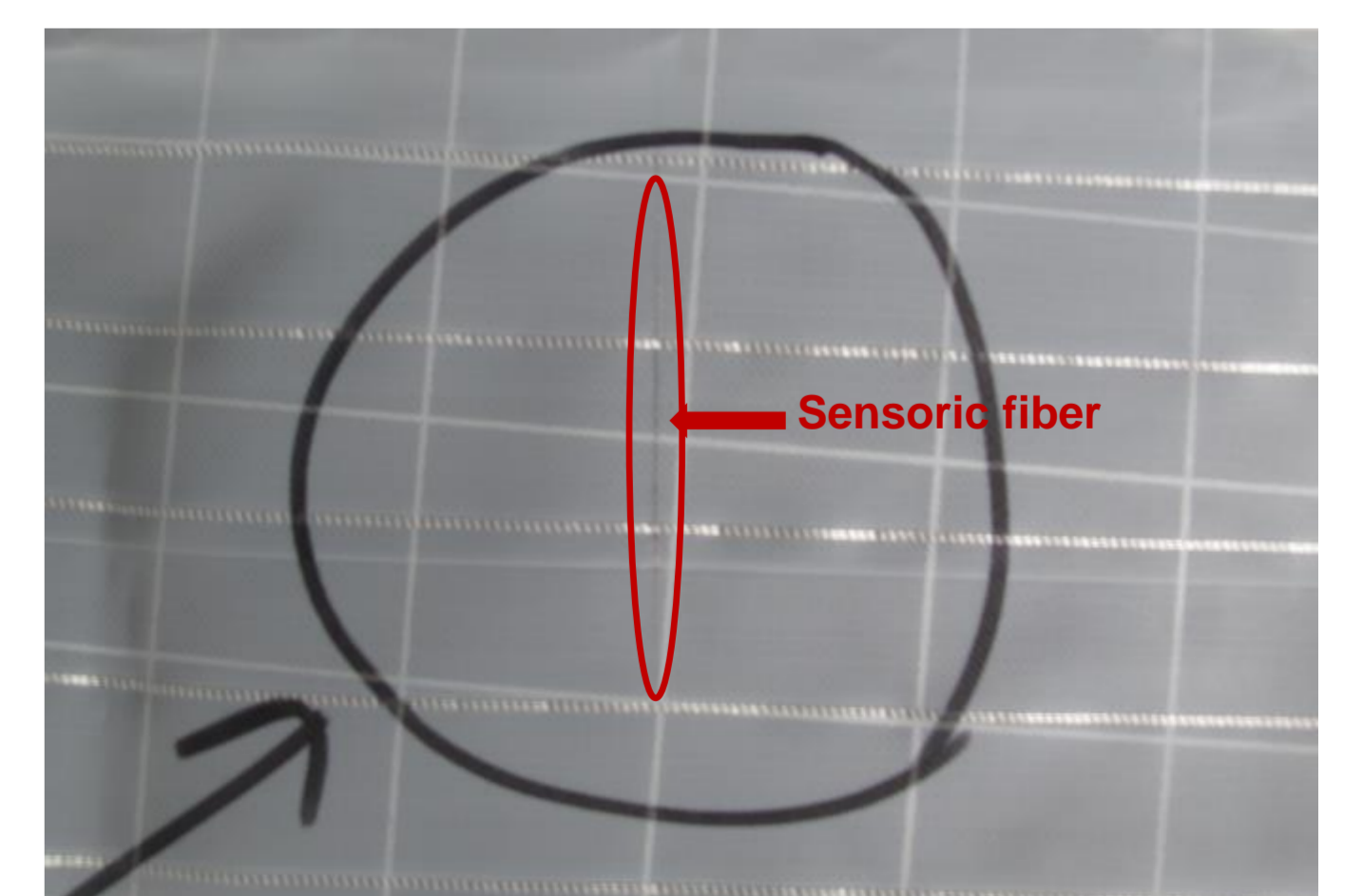
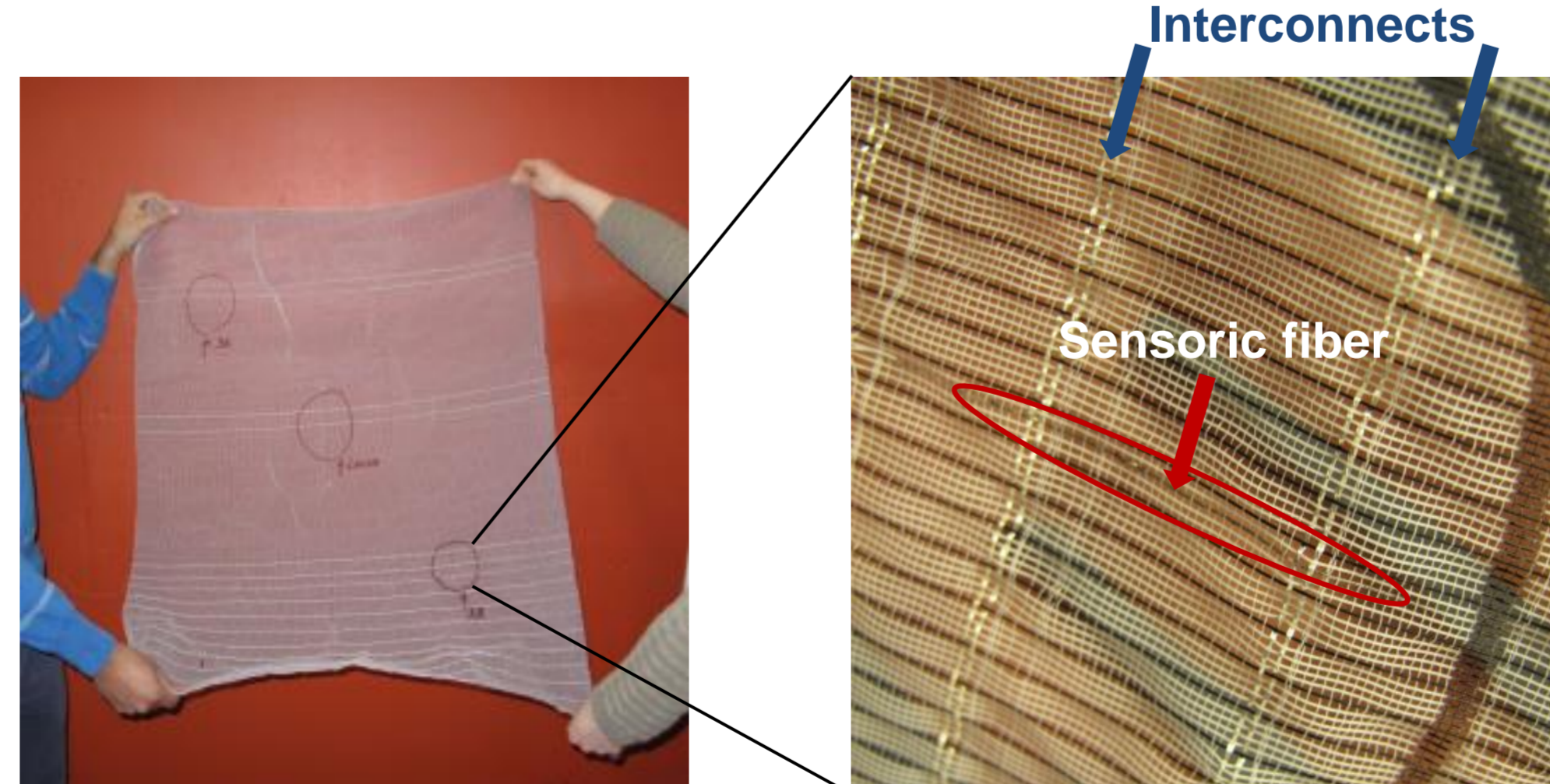
### Wrapping of TFTs foil around 125 $\mu\text{m}$ cylindrical fibers



TFT	Ion/Ioff	Vth(V)	$\mu$ ( $\text{cm}^2/\text{Vs}$ )
Before	2e6	0.92	7
after	2e7	0.86	7.2



### Industrial weaving of PET fibers functionalized with inkjet printed capacitors



## Conclusions

- Direct fabrication of capacitors on fibers by inkjet-printing and characterisation of their performances as strain sensors
- TFTs on foil transferred on cylindrical fibers by wrapping and comparison of characteristics before and after transfer
- Weaving of 10 meters long functionalized fibers using an industrial machine with proper alignment
- Overall robustness of the functionalized fibers requires improvements to be fully operational after weaving process
- We are considering to apply additive processes (e.g. printing) to functionalise the textile after its weaving