Flexible, sensitive and breathable composite reinforced by e-textile for the development of a skin model

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Introduction

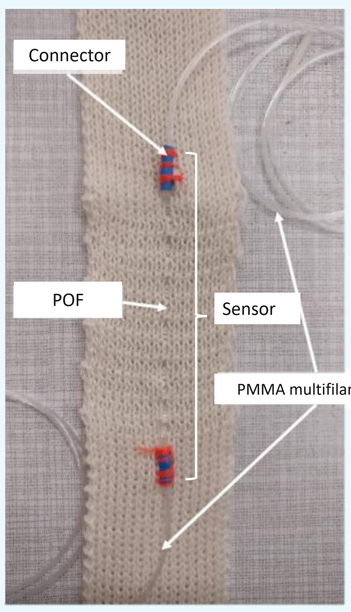
The project aims to develop an instrumented skin model representing the anisotropic elasticity of the skin. It will be able to sweat to analyse mechanical stresses during wet friction and compression with textile materials. Primarily to accelerate the development of anti-ulcer prevention products (industrial application).

The model adopts 2 phases:

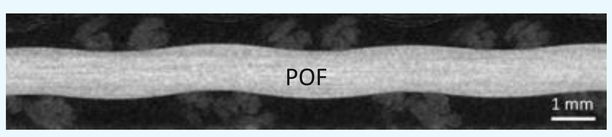
- The POF (polymeric optical fibre) integrated into the knitted fabric → implementation
- The PDMS (polydimethylsiloxane) matrix or pad to replicate the mechanical properties of the skin

Sensor design

POF implementation into a knitted fabric



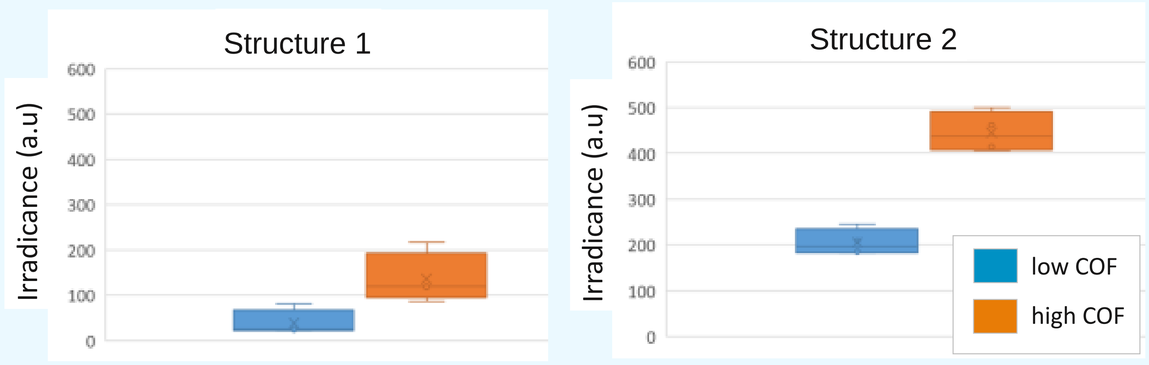
POF inserted into the knitted fabric



Microtomography picture of POF in knitted fabric

Limiting the POF radius of curvature to limit light loss is achieved by a specific knitting process.

Specific sensor for pressure and friction measurement

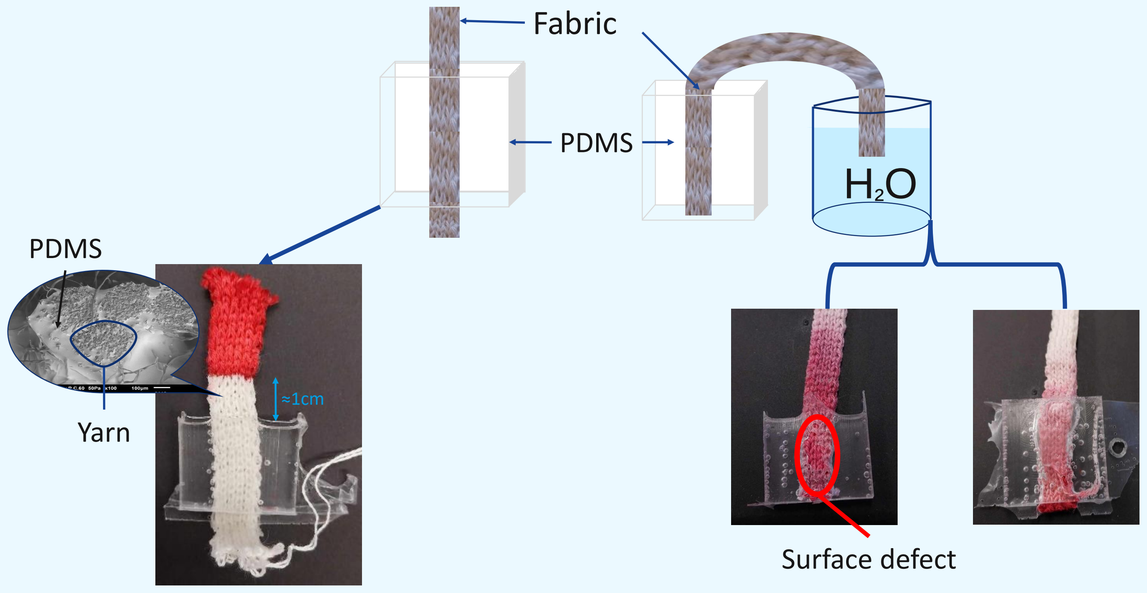


Friction behaviour for 2 different knitted structures giving a low (Lorica®) and a high (silicone) COF against textiles

By changing the knitted structure, friction or compression sensitivity can be tuned.

Bahin *et al. Sensors and Actuators A, 2023.*
Bahin, PhD thesis 2023, Université de Haute Alsace

Perspiration property: wicking behaviour



With classic cross-linking:
- Capillarity ✗
- Wear resistance ✗

With cross-linking into water:
- Capillarity ✓
- Wear resistance ✗

To take advantage of the knitted fabric capillarity for sweating mimicking**, the knitting will be at the contact surface.**
The sweating regime will be from in infinite reservoir.

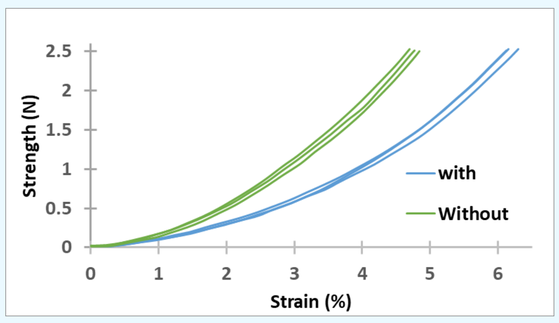
Mimicking the mechanical hardness of the skin: compression behaviour

PDMS pads

Without hole

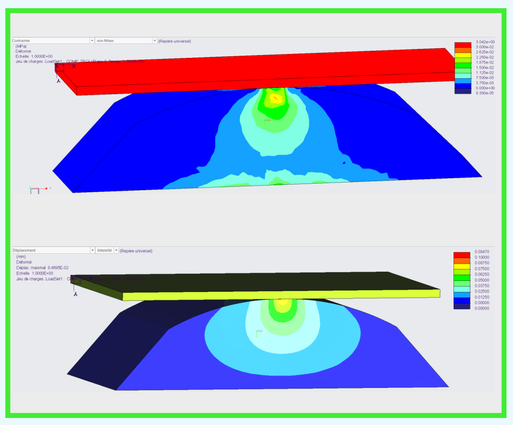
With hole (Ø 3 mm)

Experiments



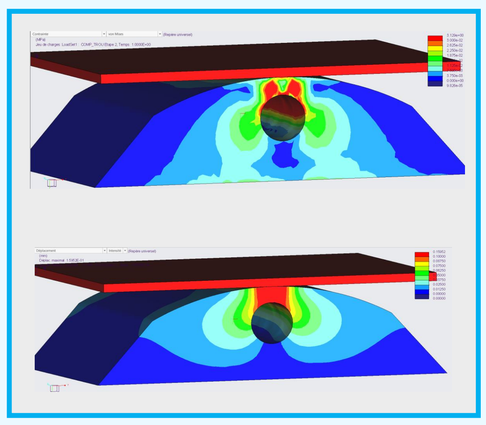
The hole presence reduces PDMS pad stiffness

FEM simulations



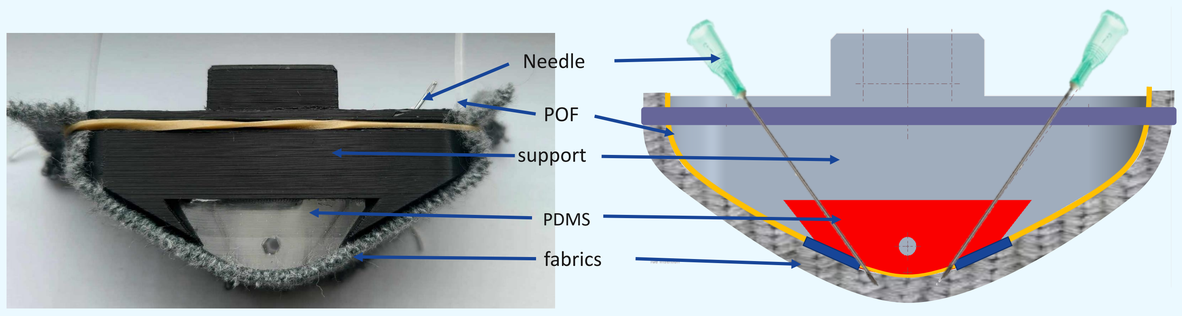
Von Mises stress (MPa)

Displacement



Displacements are higher with a large hole for the same load
→ **lower stiffness**
Point of attention Von Mises stresses are higher around the hole

Conclusions and Prospects



The first prototype takes into account all the requirements: sensitive (POF), soft in compression, sweating capability.

The shape is studied to minimise POF curvature and maximise sample/sensor contact.

The next step is to find the best hole size to mimic skin properties and to test the whole system friction/compression behaviour in dry and wet conditions.