Additive manufacturing for large scale electronic skin
Laurent Dejace
Supervisors: H. Michaud, Prof. V. Michaud, Prof. S. P. Lacour
Laboratory for Soft Bioelectronic Interfaces (LSBI), EPFL Laboratory of Polymer and Composite Technology (LTC), EPFL

Context
Design and manufacturing of soft and tactile skin for prosthetic applications

Electronic skin:
- Senses like human skin
  Functional integrated electronic circuit
- Conforms complex shapes
  Expand and relax reversibly
- Interfaces with the nervous system
  Biocompatible and soft touch nature

The WiseSkin project
- Rigid PCB sensors integration on a prosthetic hand.
- Embedment in 3D-printed silicone scaffolds.

3D-printing (MultiJet-Modeling)
- Mechanism
- Candidate scaffold materials

PDMS
- Soft (E = 2 MPa)
- Stretchable (fracture strain = 200 %)
- Chemically stable

TangoBlack
- Soft (E = 300 kPa)
- Stretchable (fracture strain = 200 %)
- Unknown chemistry

- Printable materials (Stratasys)
VeroWhite (Young modulus E = 2 GPa) → Mold synthesis → PDMS scaffold by injection.
TangoBlack (Young modulus E = 300 kPa) → Direct scaffold printing.

Scaffolds
Two approaches: Injection molding or direct printing

VeroWhite® mold (lower part)
Injected PDMS hand
3D-printed TangoBlack® hand

- VeroWhite® molds dip-coated in poly(dopamine) to solve PDMS curing issues [2].
- PDMS and TangoBlack® hands; parallel surface roughness lines due to the inkjet print heads.
- PDMS scaffold hand → better adhesion with PDMS encapsulation layers → selected.
- Finger scaffold with VeroWhite® mock-ups and encapsulated with PDMS layers ruptures at 30 %.

Sample fabrication

Sample Parameters
- Samples
  100 cycles
  Au/Cr on PDMS
  ε = 1 %/s
  L = 2 cm
  Wa = 0.5 mm

Results
- Sheet resistance (R_s)
- Gauge factor (GF)

Conclusions
- PDMS hand-shaped scaffold injected in 3D-printed mold.
- Insertion of wireless sensing nodes in a skin-like system.
- PDMS scaffold ruptures at 30 % strain → Suitable for application.

Acknowledgements
H. Michaud, Prof. V. Michaud, Prof. S. P. Lacour, LSBB and LTC members, MMHC center, Additive Manufacturing Workshop (3iR-PAT), Center of MicroNanoTechnology (CMI), EPFL

References