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3D PRINTABLE, SELF-HEALING AND IONIC CONDUCTIVE HYDROGEL FOR SELF POWERED TACTILE SENSORS

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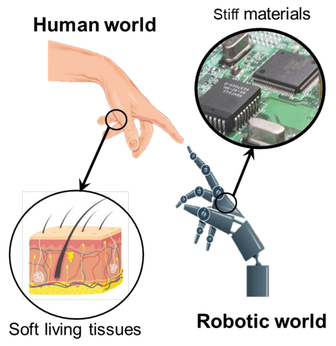
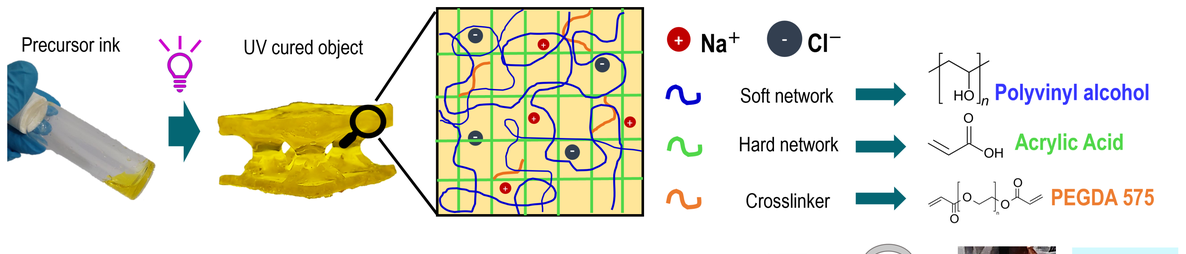
Research context and motivation

- The exponential expansion of technology has enhanced the need to interface the soft human world with the robotic one.
- **Tactile or smart sensors**, namely devices that can mimic the human tactile system sensing external stimuli, could serve as a bridge between the living soft tissues and the rigid electronic components.
- **Hydrogels** are optimal candidate to produce flexible sensors due to the tunability of their mechanical and electrical properties and intrinsic softness.

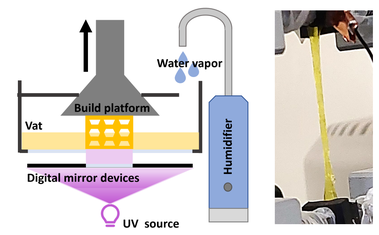


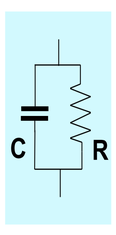
Adopted methodologies

- **Dissolving NaCl** in the precursor solution of a UV curable hydrogel (**PVA/AAc/PEGDA**)[1]→**ionically conductive**

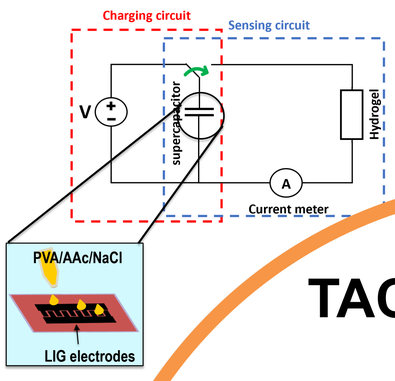


- **DLP (Digital Light processing)** 3D printing of the ink through the support of a **humidifier** → water evaporation during printing reduced





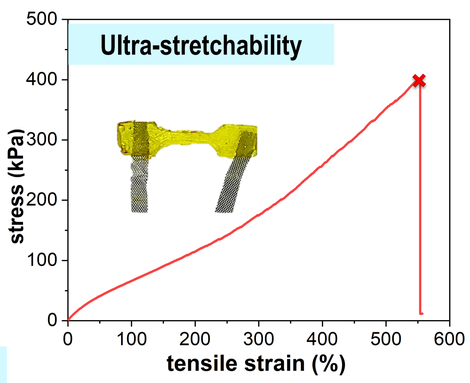
- LCR meter (1000 Hz, 50 mV) for electrical test, modelling its impedance as a **resistor parallel to a capacitor (piezoresistance/piezocapacitance transduction modes)**
- **Tensile** and **compression** analyses coupled with electrical measures
- Coupling with an interdigited **Laser-Induced Graphene (LIG) supercapacitor**[2] that owns the same PVA/AAc/NaCl hydrogel as electrolyte, analyzed

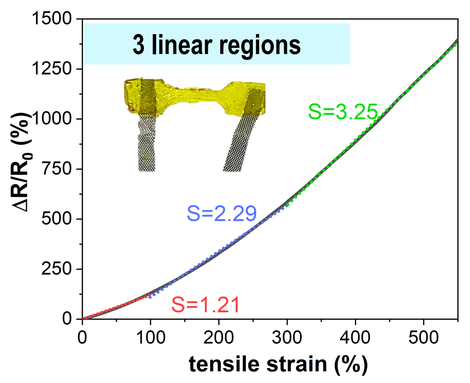


[1] M. Caprioli, I. Roppolo, A. Chiappone, L. Larush, C. F. Pirri, S. Magdassi, Nat Commun 2021, 12, 2462. https://doi.org/10.1038/s41467-021-22802-z
[2] P. Zaccagnini, A. Lamberti, Appl Phys Lett 2022, 120, 100501. https://doi.org/10.1063/5.0078707

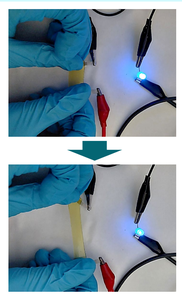
Flexible strain sensor

When stretched, migration path of ions increases → **Resistance increases**

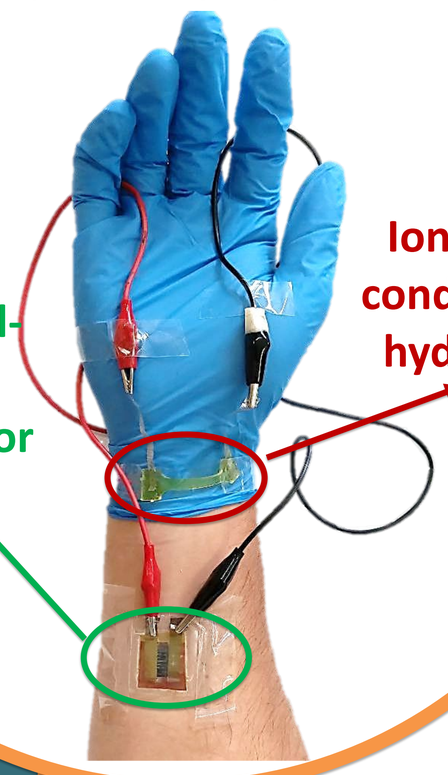




Ionic conductivity

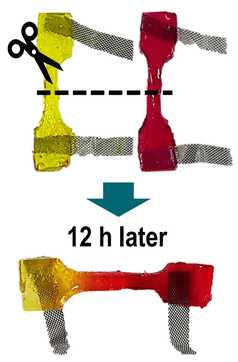


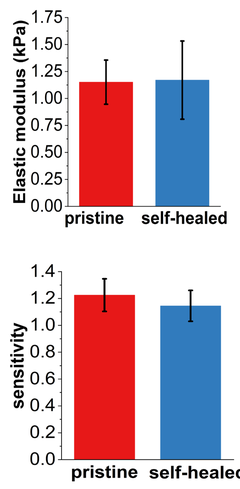
TACTILE SYSTEM



Self-healing

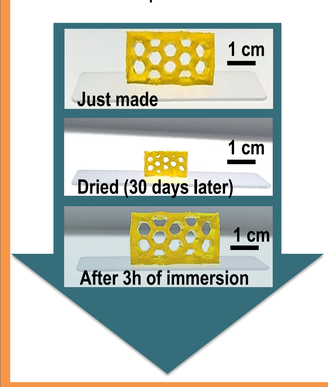
Autonomous self-healing mediated by PVA → Soft network recovery → **Electrical and mechanical recovery**

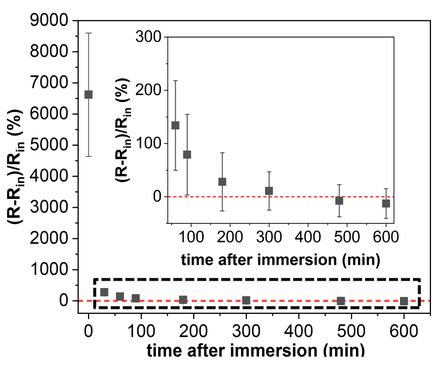




Recovery by immersion in water

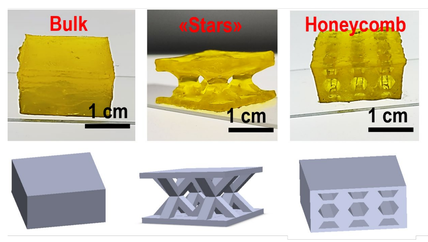
Problem: water evaporates! → Immersion for **3h** in DI water 1M NaCl



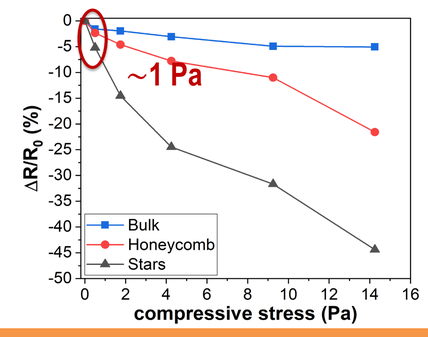


3D printing

Complex geometries improve **stress and pressure sensing** abilities



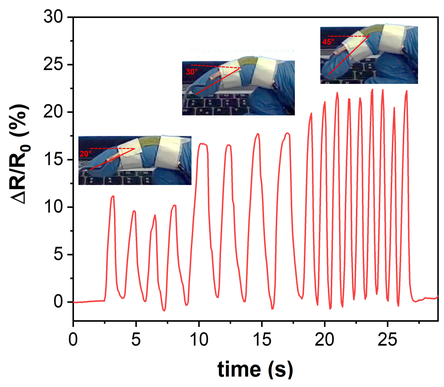
Low pressure detection limit

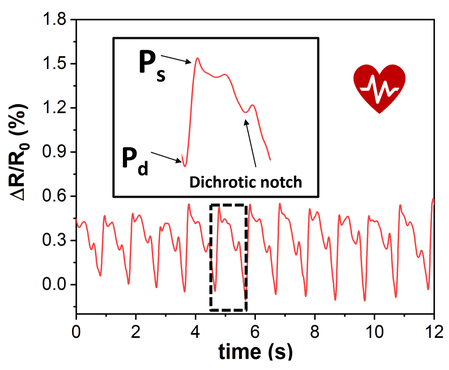


Bio-signals monitoring

Comformability to irregular surfaces

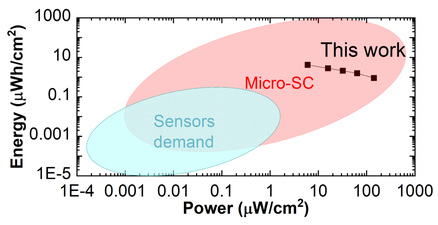
Both large and small deformations sensing





Self-powered system

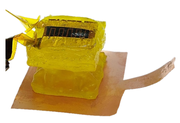
PVA/AAc/NaCl used as electrolyte

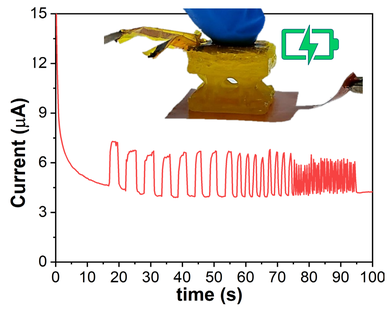


2 configurations:
1. **External** SC
2. **Integrated** SC in a 3D structure

1. Pouch closing

2. Closed through hydrogel formulation





G. Mogli *et al.*, "Self-Powered Integrated Tactile Sensing System Based on Ultrastretchable, Self-Healing and 3D Printable Ionic Conductive Hydrogel," *Advanced Functional Materials,* vol. 34, no. 7, 2023.

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