Bio-based Organohydrogels For Pressure and Strain Sensor Applications

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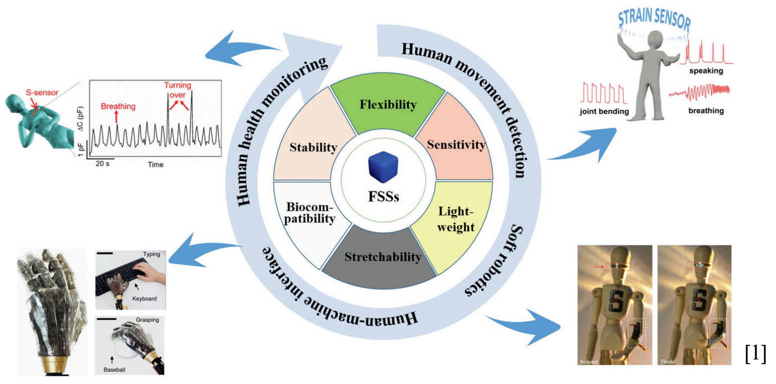
1 Objective



This project aims to **develop novel bio-based materials** that exhibit both **stretchability and electrical conductivity**, with potential applications in wearable sensing devices for strain and pressure detection. In the initial phase, **carrageenan (CG), a bio-derived polymer, was employed as the organohydrogel matrix and integrated with PEDOT:PSS** to serve as conductive components within the organohydrogel system.

2 Methodology

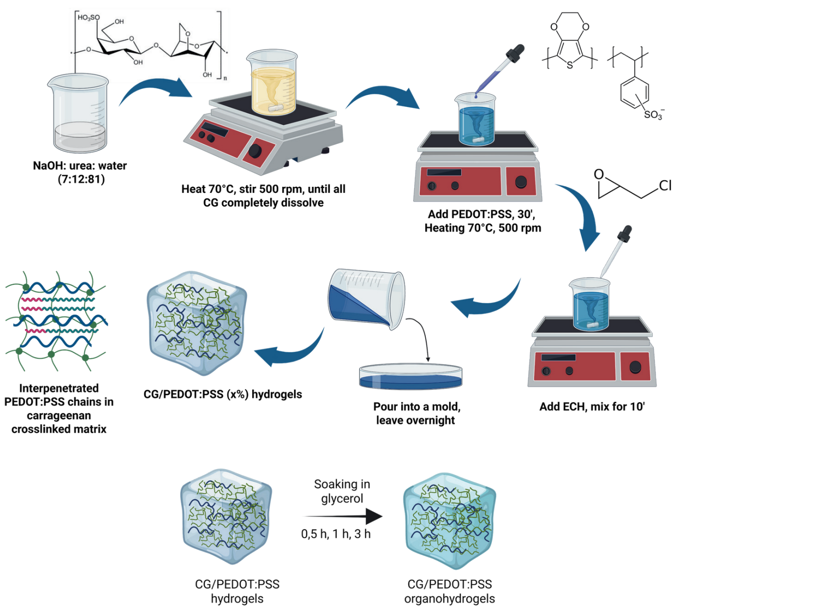


Figure 1. Schematic diagram depicting the preparation of CG_PEDOT:PSS hydrogels, followed by a glycerol immersion treatment to generate CG_PEDOT:PSS organohydrogels.

3 Results

FTIR & Weight Analysis

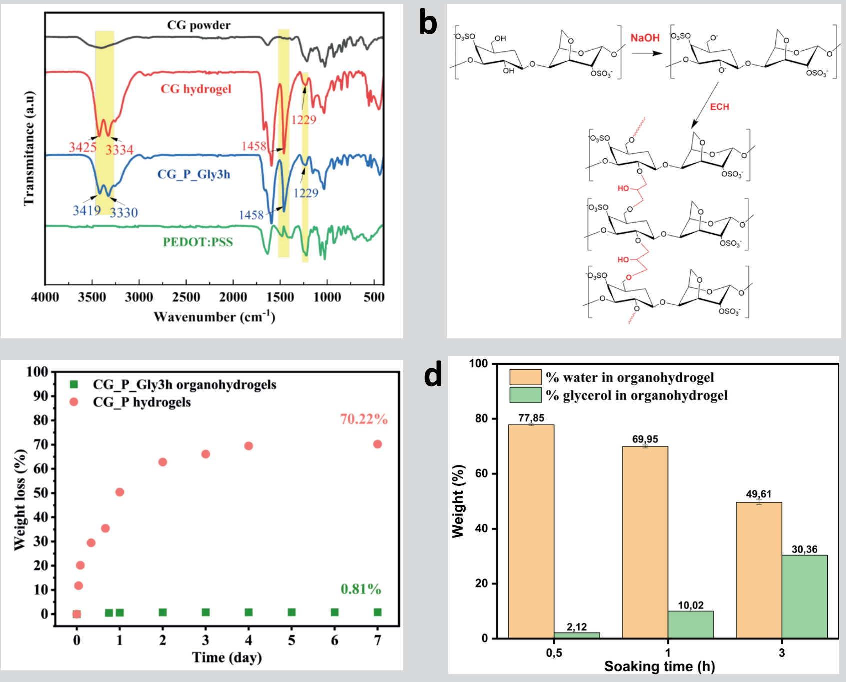


Figure 2. (a) FTIR spectra of CG powder, CG hydrogel, CG_P organohydrogels, and PEDOT:PSS (b) potential chemical structure of carrageenan crosslinked by epichlorohydrin; (c) weight loss analysis of CG_P hydrogels and CG_P organohydrogels under a temperature of 21°C and a humidity of 30% for 7 days; and (d) water-to-glycerol weight ratio in organohydrogels with varying soaking times.

Electrical and mechanical properties of CG/PEDOT:PSS organohydrogels

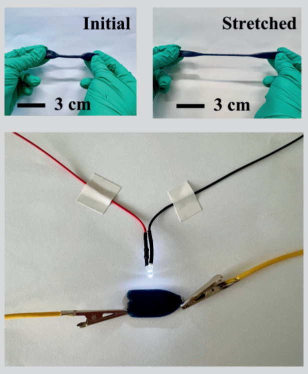


Figure 3. A photograph of CG_PEDOT:PSS organohydrogels under stretching and when used as electrical connections to wire a bulb.

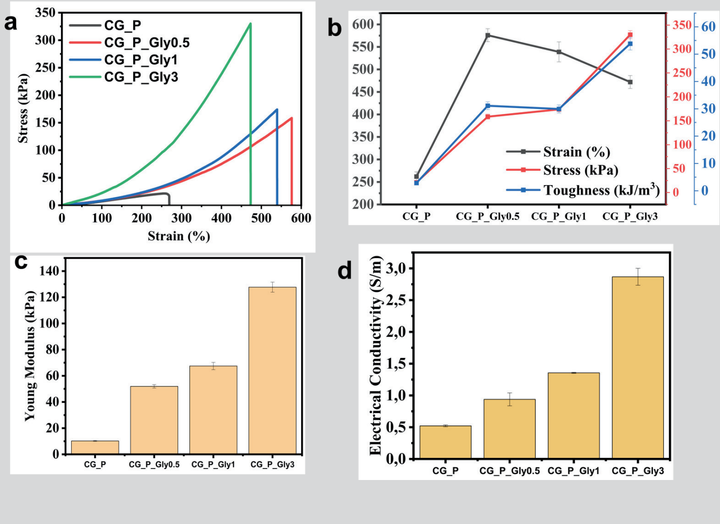


Figure 4. (a) Stress-strain curves, (b) tensile strain, stress at maximum, and toughness plot, (c) modulus young, and (d) electrical conductivity results of CG_PEDOT:PSS organohydrogels and CG_PEDOT:PSS hydrogels

***CG_P_Gly(x) (Carrageenan_PEDOT:PSS hydrogels soaked x hour in glycerol)**

Strain sensing performance

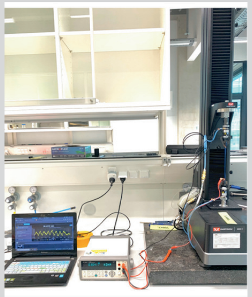


Figure 5. Configuration of strain sensor device.

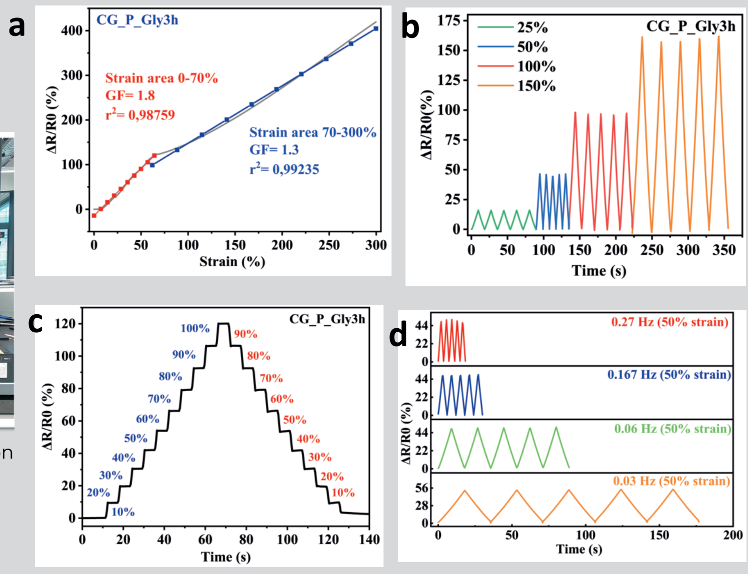


Figure 6. (a) Change in resistance versus applied strain of CG_PEDOT:PSS_Gly3h; (b) dynamic cyclic test of under varying tensile strain; (c) relative resistance response to gradually increasing and decreasing strain (d) change in resistance in response to applied strain (50%) with varying strain frequencies.

Pressure sensing performance

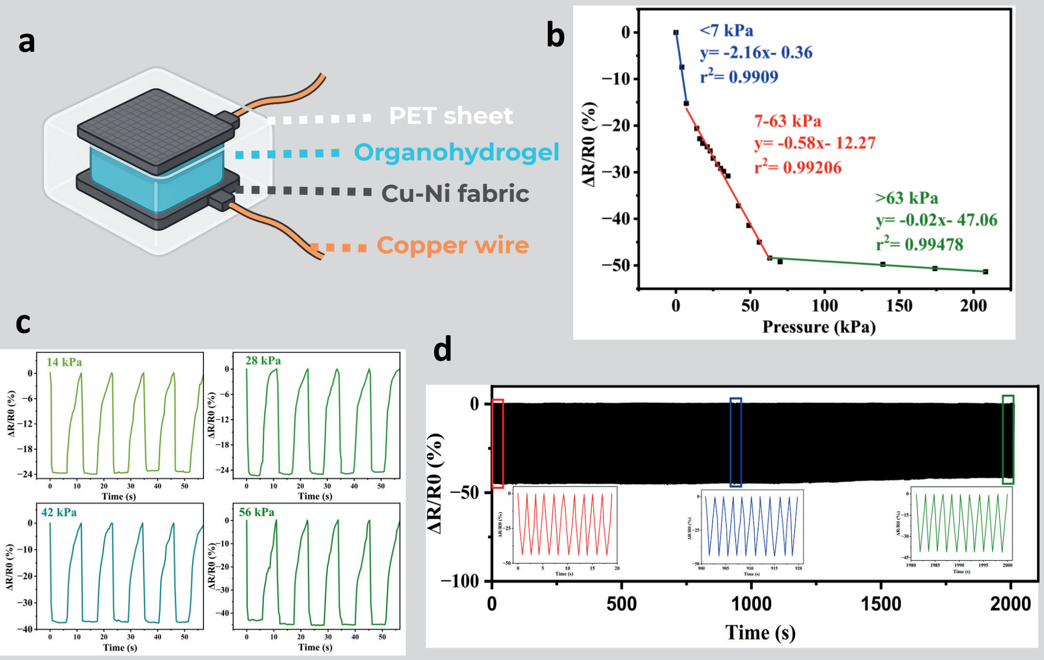


Figure 7. (a) Configuration of the pressure sensor device; (b) Change in resistance versus applied pressure of CG_P_Gly3; (c) Dynamic cyclic test of CG_P_Gly3h under varying pressures; (d) Cyclic pressure response to 49 kPa applied pressure for 1000 consecutive cycles.

4 Conclusion

- **Glycerol soaking procedure** can **effectively prevent water loss**, hence improving the structural stability of CG_PEDOT:PSS system.
- CG/PEDOT:PSS organohydrogels are capable of serving as **competitive strain and pressure sensors** due to their **exceptional stretchability** and **electrical properties**.

5 Outlook

Unravel the **sensing mechanism of the organohydrogels system** by using small-angle X-ray scattering (SAXS).

[1] Tang, L.; Wu, S.; Qu, J.; Gong, L.; Tang, J. A Review of Conductive Hydrogel Used in Flexible Strain Sensor. *Materials* 2020, *13*, 3947. https://doi.org/10.3390/ma13183947

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