Multiple applications of soft materials in thermal energy harvesting, sweat sensor, and ultrasound manipulating

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Ionic hydrogel for thermal energy harvesting

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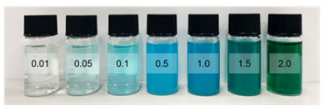
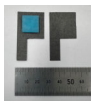
- **Fabrication of Ionic thermoelectric cells**

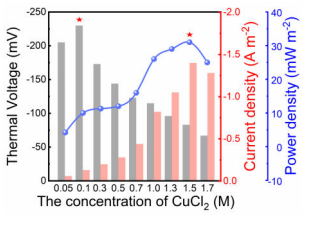


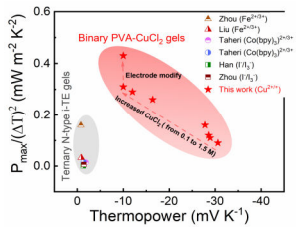


CP|PVA- *x* $CuCl_2$|CP i-TE cells

X: 0.01 to 2 M

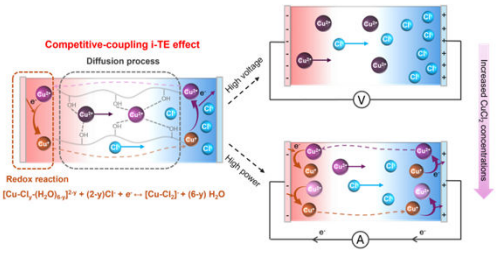
- **Exceptional i-TE properties of PVA-*x* $CuCl_2$ gels**





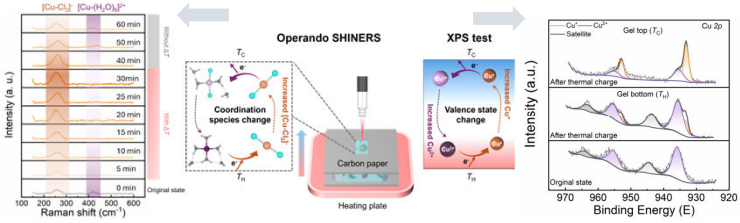
We uncovered a novel n-type thermogalvanic redox couple of $Cu^{2+/+}$ stabilized by Cl-, exhibiting exceptional performance in output power and thermopower compared with reported n-type i-TE systems.

- **Mechanism of competitive-coupling i-TE effect**



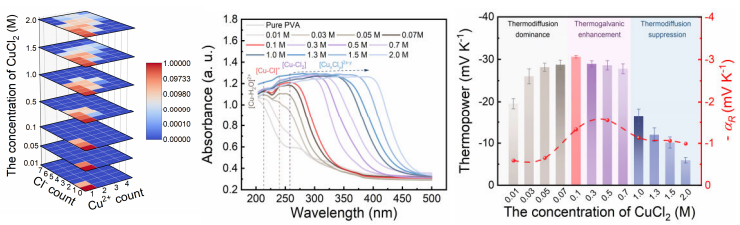
We reported a novel competitive-coupling mechanism driven by speciation in binary n-type PVA-$CuCl_2$ gels. This mechanism leads to an enhanced thermogalvanic effect with increasing $CuCl_2$ concentrations while suppressing the thermodiffusion.

- **Revelation redox reaction using operando SERS**



Our experimental characterization, combining SHINERS with surface analytical XPS characterization, is readily adaptable to other redox reaction-active hydrogels or soft-material systems, enabling precise mapping of both coordination and electronic states under operando conditions.

- **Impact of [Cu-Cl] speciation on thermopower**

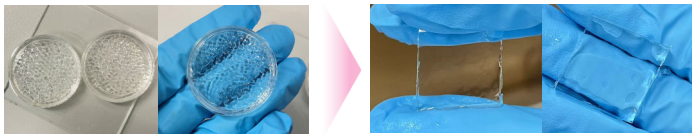


This competition driven by speciation explains the non-monotonic trend in thermopower, showing a maximum value of -30.6 mV K^{-1} at x = 0.1 M. Our findings demonstrate a novel competitive-coupling i-TE mechanism guided by coordination chemistry, offering a universal design principle for high-performance thermal-to-energy conversion systems.

Hydrogel sweat sensor for noninvasive diagnosis

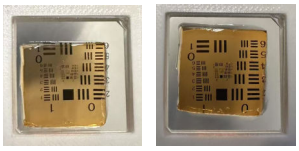
Contributors: zhouyuntong Liu (lzyt66@connect.hku.hk)

- **Fabrication of Optical Hydrogel**

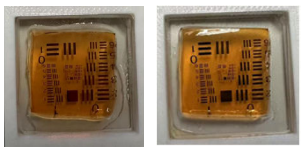


Thermal hydrogels surpass UV-polymerized in uniformity yet struggle with rough surfaces. Our optimized method yields smooth, optically clear high-n films via simple, equipment-free synthesis.

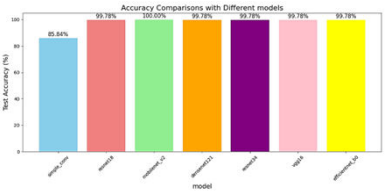
- **Analyte-Responsive Hydrogel Sensors + Neural Network Analytics**



$[Cl^-]$ = 10, 20 mmol/L



$[Cl^-]$ = 40, 50 mmol/L

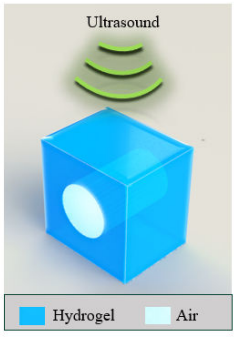


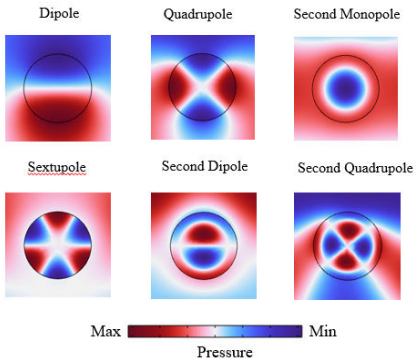
1. Hydrogel patch enables sweat uptake with sensitive biomarker recognition.
2. Excellent imaging optical clarity.
3. NN achieves near-perfect accuracy (>99.9%) in biomarker concentration detection.

Achievement of High-order Mode in ultrasound-responsive hydrogel

Contributors: Weiwei Zhang(joshuaweiweizhang@connect.hku.hk)

Ultrasound-responsive hydrogels have recently garnered widespread application in the biomedical field due to their superior biocompatibility and cost-effectiveness, particularly in the development of implantable and wearable advanced devices.





In this study, we achieved higher-order scattering modes in hydrogels by incorporating gaseous materials, demonstrating superior performance in biomedical ultrasound modulation with retrieved Q-factors. Elevated Q-values enhance device sensitivity and resolution, enabling more precise medical ultrasound applications.

Lossless Condition : $Q_{-3dB} = 10000$