**Soft, Stretchable, and Smart: Alginate/Gelatin Organohydrogels for Wearable Electronics**

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Alginate, a naturally abundant polysaccharide, offers exceptional versatility in functional material design due to its charged backbone and its ability to form ionically crosslinked networks with multivalent cations[1,2]. When combined with gelatin in a glycerol-rich medium, it gives rise to a class of organohydrogels that are not only soft and stretchable, but also responsive, robust, and fully biocompatible.

We harness this platform to engineer multifunctional hydrogels tailored for both sensing and energy-related applications. By tuning the crosslinking chemistry with $Cu^{2+}$, $Mn^{2+}$, $Fe^{3+}$, and $Zr^{4+}$ ions, we access highly adaptable materials that respond sensitively to mechanical strain (gauge factor > 1.6), temperature (0.19 $K^{-1}$), humidity (0.022 $RH(\%)^{-1}$), and light (up to 9.2 μA/W)—while retaining performance over 2500 mechanical cycles. These multiresponsive materials are ideal candidates for next-generation wearable sensors and electronic skins[3].

Building on this concept, we developed a complementary formulation serving as a gel polymer electrolyte for flexible supercapacitors. Through the synergistic interplay of $Cu^{2+}$/$Mn^{2+}$ crosslinking and $Li^{+}$ doping, we modulate nanoscale polymer structure (via SAXS) to enable high capacitance (up to 591.8 $mF/cm^2$), excellent rate performance, and long-term stability (> 88% over 5000 cycles). This work demonstrates how ionic coordination directly governs electrochemical function and mechanical resilience[4].

Together, these studies showcase a green, modular strategy for designing biopolymer-based systems that seamlessly integrate soft sensing and energy delivery—offering a scalable path toward self-powered, sustainable devices.

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[2] Tordi, P.; Ridi, F.; Samorì, P.; Bonini, M. *Adv. Funct. Mater.* 2025, 35 (9), 2416390. DOI: 10.1002/adfm.202416390

[3] Tordi, P.; Tamayo, A.; Jeong, Y.; Bonini, M.; Samorì, P. *Adv. Funct. Mater.* 2024, 34 (52), 2410663. DOI: 10.1002/adfm.202410663

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