BIOINSPIRED SOFT ELECTRONICS AND MACHINES

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Electronics of tomorrow will be imperceptible and will form a seamless link between soft, living beings and the digital world. Exploring the fundamental physics, mechanical form factors, and materials required to meet the needs of this new generation of *soft* electronics is driving multidisciplinary research worldwide. Weight, flexibility and conformability are pivotal for future wearable, soft and stretchable electronics to proliferate. The abilities to be imperceptible, epidermal, transient and self-healing are fueling the vision of autonomous smart appliances to be embedded everywhere, on textiles, on our skin, and even in our body.
We here introduce a technology platform for the development of large-area, ultrathin and lightweight electronic and photonic devices, including solar cells[1,2], light emitting diodes[3] and photodetectors[4], active-matrix touch panels[5], implantable organic electronics, imperceptible electronic wraps and "sixth-sense" magnetoception[6] in electronic skins. Air stable perovskite solar cells, only 3 µm thick, endure extreme mechanical deformation and have an unprecedented power output per weight of 23 W/g. Highly flexible, stretchable organic light emitting diodes are combined with photodetectors for on-skin photonics and pulse oximetry. E-skins with GMR-based magnetic field sensors equip the wearer with an unfamiliar sense that enables perceiving of and navigating in magnetic fields. These large area sensor networks build the framework for sensor skins that are not only highly flexible but become highly stretchable when combined with engineered soft materials such as elastomers, shape memory polymers or hydrogels. We show mobile health monitoring systems, smart, tissue-like electronics and soft machines that utilize tough hydrogels[7] as soft robots, generators and adaptive lenses (Figure 1). In addition, materials and methods for achieving self-healable and biodegradable soft electronic skins and robotics are discussed.

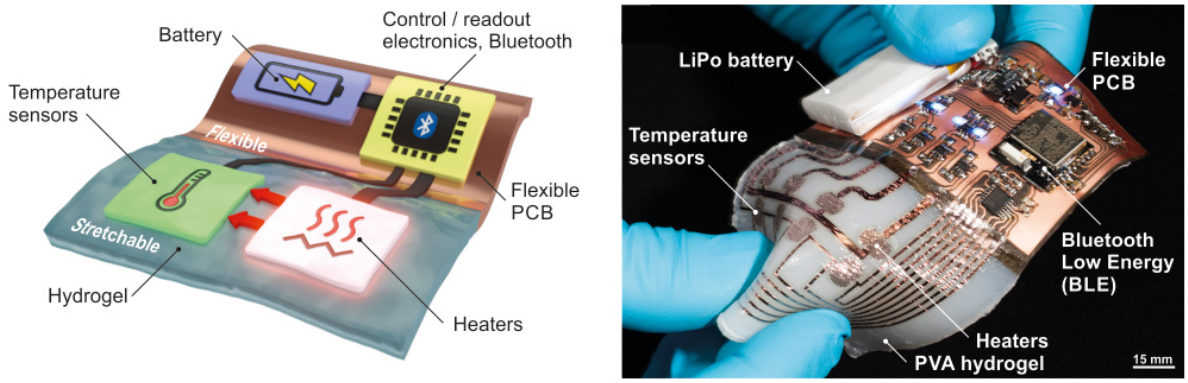

Figure 1: Hydrogel electronic skin. (left) Concept of a hydrogel smart skin, with a flexible unit bearing power supply, control, readout and communication units, and a stretchable transducer batch. (right) Photograph of an untethered electronic hydrogel with four stretchable heating elements and adjoined temperature sensors strongly bonded to a PVA hydrogel. Battery, control, readout and Bluetooth Low Energy communication electronics are hosted on a flexible circuit board.

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