Flexible and Multifunctional Electronic Skins for Wearable Devices

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Flexible electronic skins attract great attentions inthe fields of wearable devices, robotic skins, and biomedical diagnostics. Inhuman fingertip skins, fingerprint patterns and interlocked epidermal-dermalmicroridges have critical roles in amplifying and transferring tactile signals tovarious mechanoreceptors, various static and dynamic tactile signals. Inaddition, human skin possesses a high degree of flexibility and stretchabilityand can sense pressure, shear, strain, temperature, humidity, fluid flow, andpain. Here, mimicking the structures and functions of fingertip skin, weintroduce highly-sensitive, multifunctional, and flexible electronic skins.

Inspired by the interlockedmicrostructures found in epidermal-dermal ridges in human skin, we introduce multifunctionaland flexible physical sensors based on piezoresistive, ferroelectric, andtriboelectric sensing principles. We show that piezoresistive and ferroelectricskins with fingerprint-like patterns and interlocked microstructures can detectand discriminate multiple spatio-temporal tactile stimuli including static anddynamic pressure, vibration, and temperature with high sensitivities. We alsofabricate hierarchical nanoporous and interlocked microridge-structuredpolymers for the spacer-free, ultrathin, and flexible triboelectric sensors.Finally, we demonstrate a flexible ferroelectric sensor with ultrahigh pressuresensitivity and linear response over an exceptionally broad pressure rangebased on the material and structural design of ferroelectric composites with amultilayer interlocked microdome geometry. When attached on the human skin, ourelectronic skins can be used as wearable healthcare monitoring devices, whichare able to distinguish various mechanical stimuli applied in differentdirections, detect human vital signs and voice, and precisely discriminatevarious surface textures.

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