Skin-Inspired Stretchable Electronic Skins Differentiating Multi-Directional Tactile Stimuli

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Stretchable electronic skins with high sensitivities and multimodal sensing capabilities are of great interest for applications spanning from robotic skins to prosthetics and wearable healthcare monitoring systems. In human skin, the intermediate ridges at the epidermal-dermal junction are in the geometry of interlocked microstructures and enable to enhance tactile sensitivities due to stress concentration near the ridge tips. Inspired by the interlocked intermediate ridges of human skin, we herein introduce a novel design of stretchable piezoresistive electronic skins based on interlocking geometry of carbon nanotube composite elastomer films containing regular microdome-shaped arrays. These interlocked systems possess an extreme resistance-switching behavior (R_{OFF} – R_{ON} of ~10^5) and high sensitivity to pressure (-15.1 kPa^{-1}, ~0.2 Pa minimum detection) due to a giant tunneling piezoresistance between the microdome arrays.[1] As contrary to the conventional piezoresistive composite elastomer, our sensor also displays rapid response/relaxation times (~0.04 s) and a minimum dependence on temperature variation. Furthermore, our electronic skin enables to differentiate various mechanical stimuli including normal, shear, stretching, bending, and twisting forces.[2] For demonstration of the tactile-direction-sensitive and stretchable electronic skin, we fabricated a fully functional wearable electronic skin with 3×3 sensor arrays capable of selectively monitoring different intensities and directions of air flow and vibration stimuli. Finally, we shows that the electronic skin can sensitively monitor human breathing flows and voice vibrations, which should find applications in wearable human-healthcare monitoring systems.

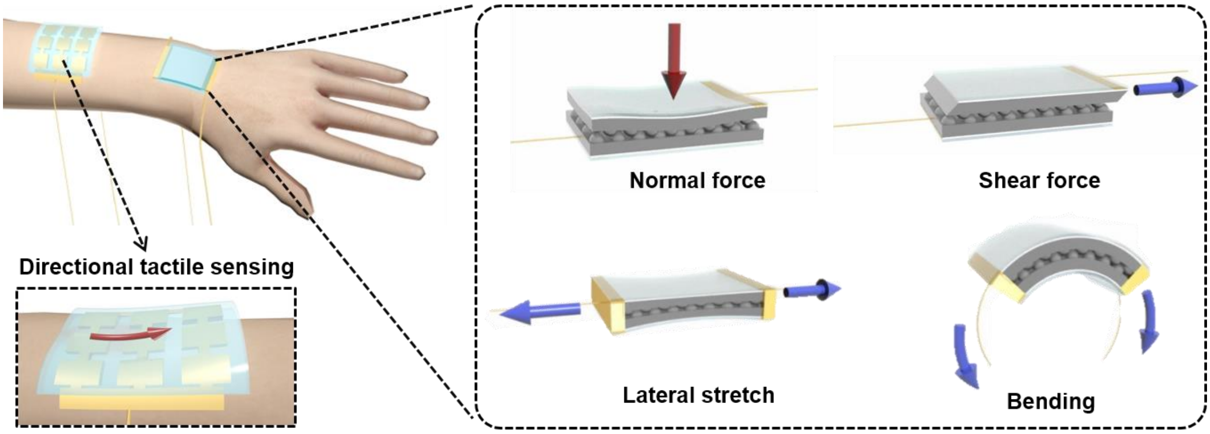

Fig. 1. Stress-direction-sensitive electronic skin for the detection and differentiation of various mechanical stimuli including normal, shear, stretching, bending forces and directional tactile sensing.

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References

1. J. Park et al. ACS Nano, 8, 4689 (2014).
2. J. Park, Y. Lee et al, ACS Nano, 8, 12020 (2014).