Wearable Dual-structured MXene for Ultra-Sensitive and Ultra-Wide Monitoring of Anatomical and Physiological Movements

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Abstract: Wearable devices for capturing anatomical and physiological movements are essential for improving the quality of life in, e.g., disease monitoring, physical rehabilitation, and assistance for people with cognitive disorders. They require high sensitivity, wide detection range, multi-functional applicability, etc. Nevertheless, current devices and technologies are challenged by simultaneous achievement of these features, mainly the sensitivity and the detection range, thus limiting their utility and applications. Herein we report on the design and production of dual microstructures of surface micro-bumps and internal hollow pores into conductive material, MXene, for obtaining multifunctional high-performance pressure sensor. The designed sensor have both ultra-high sensitivity (401.01 kPa^{-1}, 0~12 kPa), and an wide detection range (1.96 Pa ~ 100 kPa) and stability in a wide range of types of human physiological and anatomical movements, including wide range movement (joint movement and gesture), slight movement (muscle movement and wrist pulse), and synchronous movement (respiration, carotid artery, and head movement). With data-mining methods, we show an ultra-sensitive ability to extract gesture behavioral information and physiological information from the sensor signals, and its implications for human health. These performances could be used as a shuttling pad for motor function assessment and dexterous human-robot interaction for rehabilitation robots and intelligent prosthetics.