Highly-Compliant, Conformal and Stretchable Microelectrode Arrays

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Most biological tissues are supple and elastic, while current electronic devices fabricated by semiconductors and metals are usually stiff and brittle. As a result, implanted electronic devices can irritate and damage surrounding tissues, causing immune reaction and scarring. In this work, we develop stretchable microelectrode arrays, with the development of a novel soft lithography technology, which are designed and fabricated with a polymer/stretchable metal/polymer sandwich structure. With the great deformability of stretch, compression, bend and twisting, while preserving electrical property, this technology overcomes the fundamental mismatch of mechanical properties between biological tissues and electronic devices, and provides highly-compliant, conformal and stretchable bio-electronic interfaces. Here we describe devices that consist of stretchable microelectrode arrays for three of the following applications: 1) As electrocorticographic electrodes being placed on the surfaces of cerebral cortex for monitoring intracranial EEG. It is hard for traditional rigid devices to match complex, curved-surfaced cortex; however, our stretchable microelectrode arrays are capable of conformally wrapping on cortex as well as its fine features like cerebral gyri and sulci, and monitoring neural activity. 2) As tubular neural prosthesis being wrapped around peripheral nerves to repair/recover sensory and motor function after injury. Our stretchable microelectrode arrays can provide highly-compliant and conformal interface for information communication at high spatial resolution. 3) As epicardial electrocardiographic electrodes being placed on the surfaces of beating hearts for monitoring epicardial ECG. Given the capability of functioning as sensors and actuators during dynamic deformation, stretchable microelectrode arrays may potentially be utilized for monitoring and modulating dynamic organs (such as hearts, stomachs and bladders). Stretchable microelectrode arrays create a promising field in biomedical applications for its better modulus match with biological tissues and robust mechanical and electrical properties. They allow for construction of electronic integrated circuits spread over on complex and dynamic curved surfaces, providing a more friendly bio-electronic interface for diagnose, treatment and intelligent control.