Wireless epidermal electromyogram sensing system

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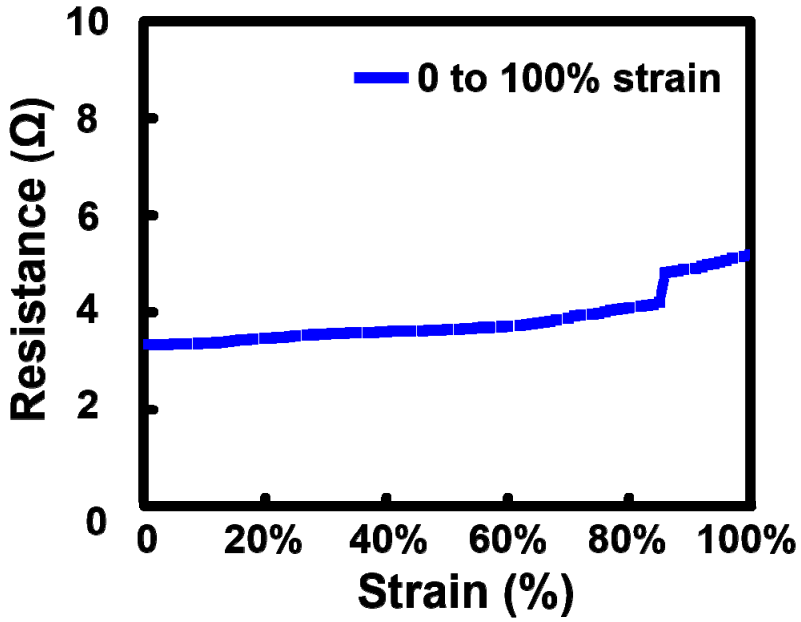

Figure S1. Resistance characteristics of the stretchale electrode patch under strain condition occuring delamination.

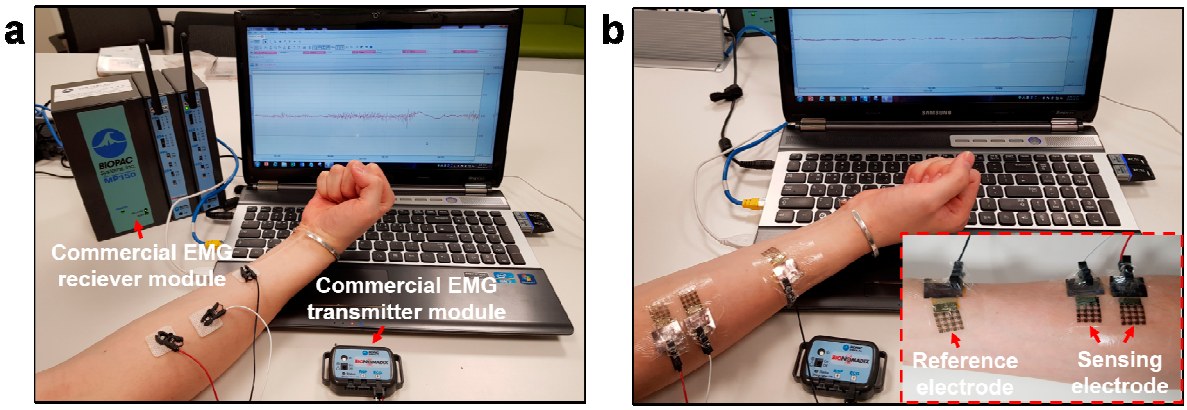

Figure S2. The experimental setup of in-vivo electromyogram (EMG) recording: (a) commercial gel-type EMG sensors and a measuring instrumentation; (b) Connection between the epidermal EMG electrodes and the commercial measuring instrumentation.

Parameter	MCU	SNR (dB)	Operating time (hr)	Data sampling rate (Hz)	Size (mm × mm)	Weight (g)
Specification	STM32F405RG	48.15	5 [500mAh]	1000	D40 × H6.2	7.6

Table S1. The specification of the wireless EMG module.

Supplementary Note 1. Additional experimental details of fabrication process

First of the fabrication process, a wafer was surface-treated with O_2 100 sccm at a pressure of 60 Pa with 300 W RF power for 5 minutes using a plasma asher (V15-G, PINK GmbH Plasma-Finish, Inc.) to ensure that the PI/metal/PI electrode, which is later manufactured, can be easily separated from the wafer substrate. After surface treatment, PI solution was spin-coated and the PI-coated wafer was baked at 250°C for 1 hour after curing for 10 minutes and ramping from 150 °C. The surface of PI-coated wafer was treated with O_2 plasma at 100 W RF power for 30 seconds to improve the adhesion of the PI and the PR to be coated on the surface. Spin-coated negative PR was soft-baked at 90 °C for 1 minute and a half and post-exposure baking (PEB) was conducted at 110 °C for 1 minute and a half before and after UV exposure respectively. The Ti/Au metal layers was deposited with a thickness of 20 nm and 300 nm respectively. After lift-off process, the surface of the wafer with a metal electrode pattern was treated once more under the same conditions as the previous step to improve the adhesion between the PI bottom layer and the PI top layer to be coated on the surface. The same plasma treatment process was additionally performed on the surface of the PI top layer to improve the adhesion of the PI top layer and the PR to be coated on the surface.

After the second lithography process, Al layer for PI backbone define was deposited at 300 nm thickness. Reactive ion etching (IPL2000E, DAEDING HIGH TECHNOLOGIES, Co., Ltd.) process was performed at 200 W RF power with O_2 plasma.

Supplementary Note 2. The result of stretching test under 100% strain

The resistance characteristics of the stretchable electrode patch under strain range more than the maximum tensile range of human skin was characterized. With stretched up to 100% which is more than 3 times the maximum deformation range of human skin. A stretchable electrode maintained a resistance of less than 10 ohms under 100% strain indicating its electrical stability. Nevertheless, in the stretching range of more than 80%, it was found that the stretchable electrode was not mechanically stable, as its electrode component was delaminated from the PDMS substrate. In summary, the developed stretchable electrode patch maintained its electrical and mechanical properties stably at 2 times the maximum deformation range of the human skin.