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Low Noise operation of Flexible, Stretchable Electronics and its Application to Imperceptible Brain Monitoring

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Abstract

We present the recent progresses and future prospects of flexible and stretchable electronics that can measure microvolt (μV) bio-signals, and demonstrate its feasibility for application to wireless brain monitoring systems. We also discuss flexible functional organic materials, ultra-low noise interfaces in which the fluctuation of carrier density is suppressed, and their integration technologies.

In the IoT/AI society, the provision of high-quality signals without noise (that is, a high signal-to-noise ratio (SNR)) is one of the most important performance requirements for electronics. For realizing high SNR, we have developed a noise reduction technique utilizing an ultraflexible and bio-conformable organic differential amplification circuit with self-assembled monolayers (SAMs) as the gate dielectric. This sheet-type differential amplifier circuit is capable of amplifying differential input signals while suppressing the common-mode noise. This organic circuit was fabricated on an ultraflexible 1-μm-thick parylene foil with p-channel organic TFTs and thin-film capacitors; therefore, it shows high mechanical flexibility and can be attached onto the human skin surface.

To demonstrate the feasibility of the developed circuit for improving signal integrity in biosignal monitoring, we recorded human electrocardiogram (ECG) and electroencephalogram (EEG) signals. The SNR with microvolt-input was considerably improved by utilizing the differential amplification circuit.

In addition to the flexible amplifier circuits, the system and material technologies for reducing noise and the future prospects using ultra-low noise electronic systems are also discussed.