Remote medical service / Digital healthcare, IoT device, AR/VR/MR technology

High-precision electrical characteristics control for flexible organic electronic circuits

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Abstract

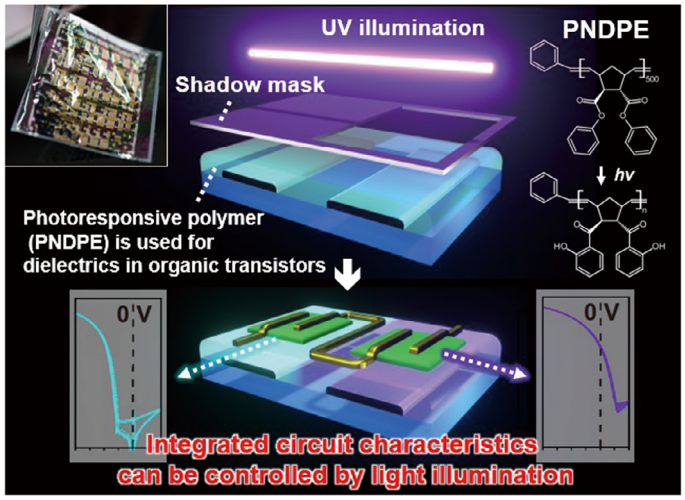
Ultra-lightweight and flexible electronic devices have been studied to build imperceptible wearable sensors, aiming to realize a sustainable health society realized with digital healthcare technology. This is because imperceptible wearable sensors are a new device technology that makes it possible to monitor a person's health over time and quickly detect health status problems. In this research, we have successfully changed the characteristics of flexible integrated circuits by using a polymer material whose molecular structure changes upon light irradiation as an insulating layer of organic transistors. This technology allows the electrical characteristics of organic electronic circuits to be freely changed by light irradiation. This technology can significantly improve the power consumption performance of flexible transistor circuits.

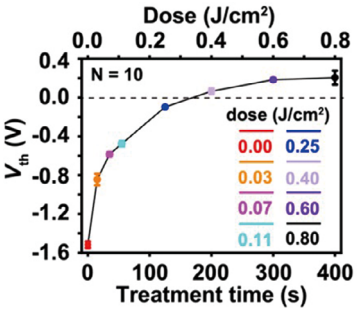
Background & Results

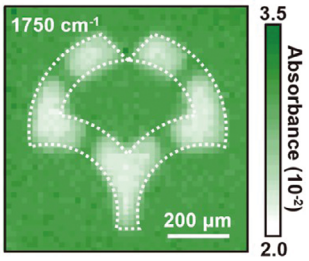
Our research group has been developing flexible organic circuits utilizing organic electronic materials with high mechanical flexibility. However, flexible sensor devices that realize biological signal measurement consist of multiple electronic functions, such as switching and signal processing circuits. Therefore, the development of technology to control the electrical characteristics of individual transistors was required to obtain the desired device performance. In this study, the research group has developed a technology to control electrical characteristics by light irradiation. With this technology, the threshold voltage, applied gate voltage at which the organic transistor switches ON and OFF, can be arbitrarily adjusted in the range of -1.5 V to +0.2 V. The light-based technology also has an excellent two-dimensional spatial resolution for characteristic control. In this study, it was confirmed that molecular structure changes can be induced with an accuracy of approximately 18 μm. Moreover, this technology can be applied to manufacture smaller circuits with higher integration levels by the improvement of light irradiation conditions. In addition, it is becoming clear that this technology can be applied to p-type and n-type transistors. It enables complementary circuits that achieve low power consumption through precise control of electrical characteristics. Specifically, it is possible to fabricate the different functional groups on the same substrate freely. For example, low-power and high-speed circuit groups are integrated on the same substrate.

Significance of the research and Future perspective

This research result shows that the characteristics of flexible organic electronic circuits can be controlled by a simple process using light irradiation and fewer materials compared to conventional techniques. This technology is expected to enable higher performance of flexible electronic circuits and be utilized as a sensing technology for many kinds of object in real space. It will help to realize imperceptible wearable biomedical sensors, an essential technology in future remote medical service and digital health care.







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Treatise Taguchi, Koki; Uemura, Takafumi; Sekitani, Tsuyoshi et al. Heterogeneous Functional Dielectric Patterns for Charge-Carrier Modulation in Ultraflexible Organic Integrated Circuits. Advanced Materials. 2021, 33, 2104446, doi: 10.1002/adma.202104446

URL https://resou.osaka-u.ac.jp/ja/research/2021/20210921_2
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Keyword flexible electronics, wearable electronics, organic semiconductor