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Transparent and Flexible All-Organic Multi-Functional Sensing Devices Based on Field-effect Transistor Structure

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Transparent and flexible electronic devices that are light-weight, unbreakable, low power consumption, optically transparent, and mechanical flexible possibly have great potential in new applications of digital gadgets. Potential applications include transparent displays, heads-up display, sensor, and artificial skin. Recent reports on transparent and flexible field-effect transistors (tf-FETs) have focused on improving mechanical properties, optical transmittance, and performances. Most of tf-FET devices were fabricated with transparent oxide semiconductors which mechanical flexibility is limited. And, there have been no reports of transparent and flexible all-organic tf-FETs fabricated with organic semiconductor channel, gate dielectric, gate electrode, source/drain electrode, and encapsulation for sensor applications. We present the first demonstration of transparent, flexible all-organic sensor based on multifunctional organic FETs with organic semiconductor channel, gate dielectric, and electrodes having a capability of sensing infrared (IR) radiation and mechanical strain. The key component of our device design is to integrate the poly(vinylidene fluoride-triflouroethylene) (P(VDF-TrFE) co-polymer directly into transparent and flexible OFETs as a multi-functional dielectric layer, which has both piezoelectric and pyroelectric properties. The P(VDF-TrFE) co-polumer gate dielectric has a high sensitivity to the wavelength regime over 800 nm. In particular, wavelength variations of P(VDF-TrFE) molecules coincide with wavelength range of IR radiation from human body (7000 nm ~14000 nm) so that the devices are highly sensitive with IR radiation of human body. Devices were examined by measuring IR light response at different powers. After that, we continued to measure IR response under various bending radius. AC (alternating current) gate biasing method was used to separate the response of direct pyroelectric gate dielectric and other electrical parameters such as mobility, capacitance, and contact resistance. Experiment results demonstrate that the tf-OTFT with high sensitivity to IR radiation can be applied for IR sensors.

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