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Organic Pyroelectric Sensors Integrated in Thin-Film Transitors

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Copolymer of vinylidenefluoride and trifluoroethylene (P(VDF-TrFE)) was utilized as a pyroelectric functional gate dielectric in organic thin-film transistors (OTFTs) for pyroelectric sensor application. We first report a novel transistors operation mechanism and a positive P(VDF-TrFE) pyroelectric coefficient as effects of highly crystalline P(VDF-TrFE) material. Bottom gated, top contact organic thin film transistor with the pyroelectric P(VDF-TrFE) gate dielectric was fabricated on polyimide substrate. P(VDF-TrFE) layer was spin coated on electroplated Ni gate electrode. Pentacene semiconductor layer, then top source and drain electrodes were deposited at by a thermal evaporator. Transistor linear output characteristics even at zero gate bias were observed as an evidence of polarized gate material. A modified equation based on properties of pyroelectric gate dielectric layer was introduced to fully explain the phenomenon. Thermal response of the transistors was observed to be linear from room temperature to 60 ^{o}C and non-linear above that. Non-linear behavior of transistors at high temperature were supposed to be related to a change in semiconductor carrier mobility and phase transition of P(VDF-TrFE) layer. These results show that employing P(VDF-TrFE) as functional gate dielectric layer in OTFTs is favorable for thermal sensor applications in many industries due to simple structure, fast response, good linearity, and reliability.