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Detecting Trace Explosives with Organic Electronic Devices

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ABSTRACT

Trinitrotoluene (TNT) is a commonly used explosive and poses a significant risk to security arenas across the globe. The use of organic electronics for the detection of explosive residues allows for large scale, solution-processible, and environmentally stable devices with a high selectivity for TNT detection. Currently, fluorescence-based sensors are used in TNT detection, but the synthesis of the fluorescent molecules can be complicated and costly. Hence, we introduce a new design paradigm to overcome this limitation. Specifically, organic field-effect transistors (OFETs) were created using 6,13-bis(triisopropylsilylethynyl) (TIPS) pentacene as the active material to collect a baseline mobility and the on current to off current ratio (ON/OFF). Then, blends of TIPS-pentacene and varying concentrations of TNT were used in OFETs, and the change in the ON/OFF and charge carrier mobility were evaluated. With the introduction of TNT, the ON/OFF increases in value and it was observed that the concentration of the TNT in the film blend has an effect on how much the ON/OFF and hole mobility increases. The measured change in the ON/OFF were used to create a calibration curve that shows the dependence of the TNT concentration. A device that incorporates the TIPS-pentacene FET could eventually be used to sweep an area or surface for the presence of dangerous explosives through a change in an electrical signal in the device and interpretation of the calibration curves.

KEYWORDS

pentacene, explosives sensing, organic field-effect transistors (OFETs), organic semiconducting materials