Highly sensitive and selective gas sensor utilising tips pentacene based organic thin film transistor

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Abstract

In recent years, organic sensing technology has received a lot of attention. This type of sensor has dominated research in academia and industry because to its low fabrication cost, great sensitivity, short response, and recovery time. The bottom-gate, top-contact (B-G, T-C) arrangement was used to build and characterise organic thin film transistors (OTFTs) based on 6,13-bis(triisopropylsilylethynyl) (TIPS) pentacene in this study. After producing a clean glass substrate, a gate electrode of 50nm aluminium was thermally evaporated. The insulating layer was spin coated (2000 rpm) from a 5 percent anisole cross-linked polymethyl methacrylate (cPMMA) solution with [1,6-bis(trichlorosilyl) hexane (C6-Si) (10/1ml) as a crosslinking agent to generate a 330nm layer thickness. As the active layer, a tips-pentacene semiconductor (2 percent toluene solution) was drop coasted on the cPMMA layer. Finally, to provide the drain and source, gold electrodes with a thickness of 50nm were thermally evaporated on the TIPSpentacene active layer. The current-voltage characteristics of the OTFT sensor and the response to varied concentrations of ethanol (from 1ppm to 8ppm) were examined after the OTFTs were exposed to varied concentrations of ethanol vapour. The output characteristics (VDS = 0 – (-60) V) were studied with various gate voltages (VGS= 0 – (-50) V) and ethanol concentrations. When the OTFT is subjected to ethanol vapour at room temperature (25 Co), the drain source current in the saturation area reduces rapidly. In addition, the transfer characteristics with various ethanol concentrations revealed a noticeable shift in the threshold voltage, which rose (from -2V to -18V) as the ethanol content increased.

A sensitive and selective organic field-effect transistor (OFET) pair sensitive to nitrogen dioxide gas and five additional vapour analytes was created using the biomolecule guanine and the organic semiconductor pentacene. The OFET with the guanine-pentacene sensing unit was first found to be more sensitive to nitrogen dioxide gas. Then, when it came to the other vapour analytes, these two types of OFETs had opposite responses and/or different response magnitudes. The two OFETs' sensing responses have distinct patterns, allowing them to differentiate particular analytes such as nitrogen dioxide. The research shows how a low-cost, environmentally benign biomolecule can be used in organic electrical sensing.

One of the most promising candidates for room temperature operated gas sensors with good selectivity is the organic semiconductor gas sensor. However, organic semiconductor sensors have long lagged behind classic metal oxide gas sensors in terms of performance, particularly for the detection of oxidising gases. Following a thorough examination of the shape and electrical properties of organic films, it was discovered that ultrahigh performance is highly dependent on the film charge transfer ability, which was previously overlooked in research. And it's been shown that combining efficient charge transport with a low original charge carrier concentration is a good way to get high-performance organic semiconductor gas sensors.

As a result, the source drain current in TIPS pentacene-based OTFTs can be employed as a sensor for chemical gases and as an important metric for monitoring chemical species.

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