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Organic thin film transistors based on poly(3-hexylthiophene) and single-walled carbon nanotubes

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The percolation phenomena were investigated in organic thin film transistors (OTFTs) based on the composite films of regioregular poly(3-hexylthiophene) (P3HT) with single-walled carbon nanotubes (SWCNTs). Langmuir-Blodgett technique was used for the reproducible fabrication of the percolative OTFTs based on P3HT with a fine control of SWCNT concentration.

Depending on the relative ratio of SWCNTs, the critical behaviour near the onset of the percolation was observed. Below the percolative threshold, the source-drain current, I_{ds}, did not change noticeably, but the on-off ratio was increased with the increase of the SWCNTs in the network. Within the transition range of the percolation, the on-off ratio was the highest at the beginning of the percolative region, and sharply decreased during that range even though I_{ds} was abruptly increased. This region indicates the critical formation of the percolative conducting paths of SWCNTs. At the high loading of SWCNTs, the saturation of the drain-source current and the small on-off ratio was confirmed due to the dominant metallic natures by SWCNTs.

The percolative FETs can be a good way for enhancing the on-off ratio because of the effective contraction of the channel lengths and the critical behaviour of the percolative threshold.