第76回応用物理学会秋季学術講演会 講演予稿集 (2015 名古屋国際会議場)

Polymer chain alignment via nanochannel effect for improving transistor performance

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The use of crystalline organic nanowires is a promising strategy for developing high-performance organic field-effect transistors because of their improved carrier mobility and high compatibility with various logic circuits [1, 2]. In this work, we established a process to develop well-defined polymer nanowire transistors made of liquid-crystalline semiconducting poly(9,9-dioctyl fluorene-alt-bithiophene) (F8T2). Figures 1 show (a) a device configuration and (b) an SEM image of top view of F8T2 nanowires in nano-scaled channels of SiO_2 prepared by lithography technique. The nanochannels offer templates for forming polymer nanowires in which polymer chains are uniaxially aligned along the nanochannels through a nano-confinement effect. In addition, this process prevents the serious damage during the inevitable etching process that used to separate the nanowires from each other.

We examined the electrical properties and polymeric chain alignment of F8T2 nanowires. Nanowire transistors exhibited carrier mobilities of 3.5 and 2.8×10^3 cm^2/Vs for 54 and 130 nm wide nanowires, respectively. The carrier mobilities were about three times larger than that of a thin film transistor. Polarized UV-vis absorption analysis clarified that the improved carrier mobility can be attributed to the enhanced polymer chain alignment in the nano-channels. This approach has great potential as regards improving device performance, downsizing, and the large-scale integration of nanowire transistors with various kinds of device configurations.

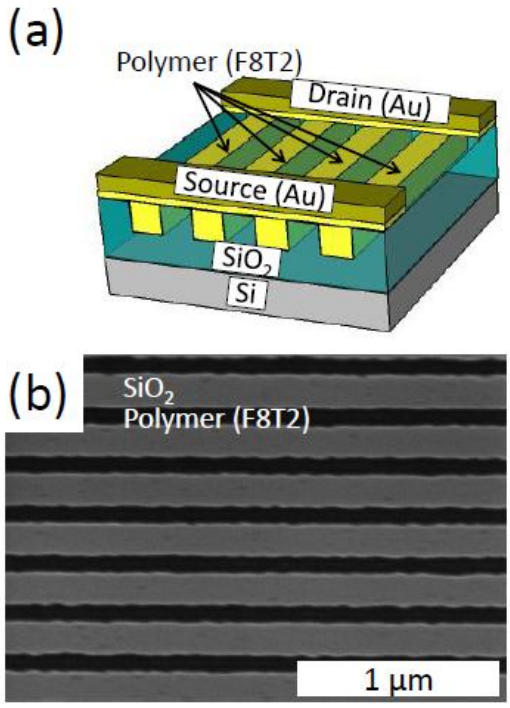

Figure 1. (a) The device configuration (b) SEM image of top view of F8T2 nanowires in patterned SiO_2

References

[1] S. Oh, R. Hayakawa, T. Chikyow, and Y. Wakayama, Appl. Phys. Lett. 2015 (in accepted).

[2] Y. Wakayama, R. Hayakawa, T. Chikyow, S. Machida, T. Nakayama, S. Egger, D. G. de Oteyza, H. Dosch, and K. Kobayashi, Nano Lett. **8** (2008) 3273.