Performance enhancement of carbon nanotube FETs via polymer-based doping control

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Abstract

The direct synthesis of polymers like sodium 4-styrenesulfonate inside the channel of carbon nanotube (CNT) based field-effect transistors (FETs) strongly improves the device performance. Starting with monomeric compounds, the FET-channel was *in-situ* passivated, using the self-initiated photografting and photopolymerization process [1]. An exemplary CNTFET as well as the polymer integration procedure is elucidated in Figure 1. Upon formation of the polymer matrix, we report increased drain currents as well as on/off current ratios, an improved device-to-device consistency, and lower variability in the threshold voltage. The change of the electrical transfer characteristics of the CNTFETs upon polymer passivation as well as a statistical evaluation of the on conductance and on/off current ratios for more than 60 devices are illustrated in Figure 2. Annealing in vacuum was shown to further improve the device performance and induces an ambipolar transport behavior due to a removal of water molecules in vicinity of the CNTs. Additionally the devices showed a long-term stability upon storage under ambient environment [2]. We present a systematic study based on different polymer integration procedures enabling to adjust the properties of CNTFETs. Those procedures elucidate improvements in essential figures of merit of the FETs by several orders of magnitude especially for wet-processed CNTFETs. We discuss the underling mechanisms based on electrical, structural and simulation studies.

This channel engineering approach opens new possibilities to tune CNTFETs key parameters that facilitate a wide application covering especially high frequency CNTFET devices and also thin film CNT transistors for flexible electronics.

Figures

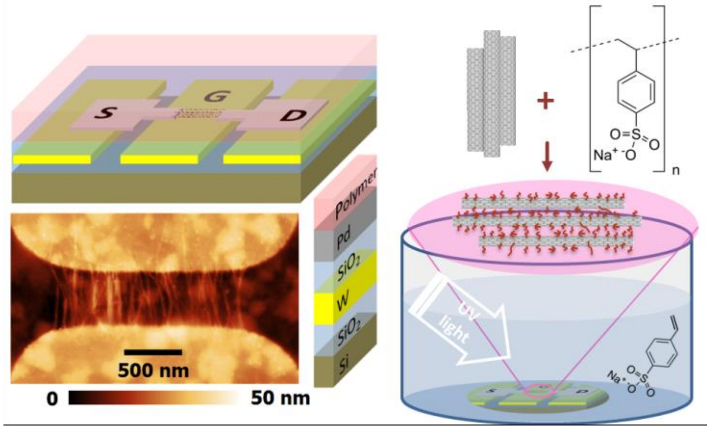

Figure 1. Schematic illustration of one CNTFET (left) and of the polymer integration procedure (right) [2]

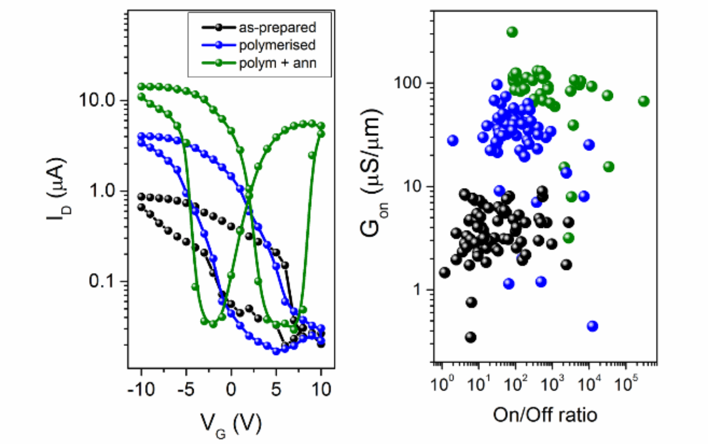

Figure 2. Electrical transfer characteristics of one CNTFET (left) and a statistical analysis of the on conductance and on/off current ratios of over 60 devices (right) [2]

References

[1] M. Steenackers et al., Langmuir 25 (2009)

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