Highly-stable carbon nanotube - graphene devices for optoelectronic applications

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Carbon nanotube optoelectronics and especially carbon nanotubes as emerging quantum-light sources have become recently very active research areas [1]. In this context we have developed electrically-driven carbon nanotube on-chip light sources integrated in optical waveguides and complete quantum photonic circuits [2,3]. Currently we are working intensively on interface engineering to obtain more stable operating points and reduced hysteresis. In particular we focus on surface functionalization, graphene as electrode material and air-tight packaging [4,5,6].
In this study we report on highly stable, hysteresis-free CNTs field effect transistors with monochiral (9,8) nanotubes for emission in the telecom band. Reproducible device operation points were obtained by a combination of graphene or nanocrystalline graphene (NCG) as electrode material, Trimethylsilyl (TMS) self-assembled monolayer (SAM) as hydrophobic surface layer and Teflon-AF coating as protective layer against the environment. In comparison to conventional devices (Pd electrodes on bare SiO2/Si) we observe transfer curves that are essentially hysteresis free and in consequence stable light emission (figure 1).

Figure

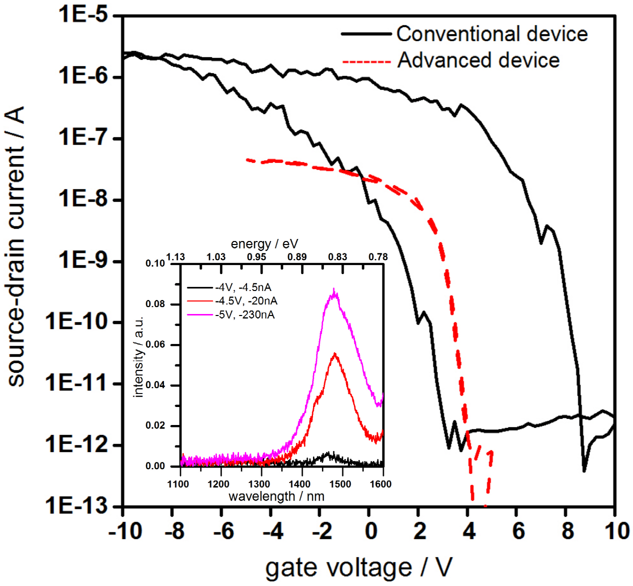

Figure 1: Highly stable and hysteresis-free transfer characteristics of an advanced (9,8)-CNT-NCG-FET encapsulated in TMS-SAM and Teflon-AF (red dashed line), in comparison with a conventional (9,8)-CNT-Pd-FET (black line). Both devices were fabricated on 300nm SiO_2/Si substrates. Inset shows electroluminescence spectra of a stable device at different electrical excitation power (source-drain voltage, source-drain current).

References

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