Noise Properties of Carbon Nanotube FETs with Top and Side Gate Geometries: Effect of Gamma Irradiation

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Abstract

Carbon nanotubes (CNTs) are a very promising material for future nanoscale electronic systems. One of the applications where they can be used is field-effect transistors (FETs). The design and fabrication of appropriate contacts represents one of the main issues because this determines the transport regimes in the structure. However, several issues remain unsolved, e.g., the impact of interface morphology, area of the contact region and properties of contact barriers on mechanisms of transport formation. Gamma irradiation is widely used to modify various characteristics of different materials and even to improve the properties of the structures. In the present work, we investigated the electrical transport and noise properties of FETs by examining individual CNTs with different gate geometries and dielectric layers (Figure 1) before and after gamma radiation treatment.

![Figure 1: (a) AFM image of a CNT-FET with source (S) and drain (D) contacts, as well as two side (SG) and three top (TG) gates. The scale bar - 500nm; (b) Normalized current noise power spectral density of the FET measured at different top gate overdrive $V_{CG}-V_{th}$ at T=120K before (red curves) and after (black curves) gamma radiation treatment. $V_{ds}=30mV$.](image)

By analyzing the generation-recombination (GR) noise components, we identify the trap energies responsible for the fluctuation processes in the transport channel. We show that relatively high values of the Hooge parameters are due to the contribution of Schottky barriers to the conductivity of the structures near the threshold voltage. The exposure of the FET devices to gamma irradiation has a positive impact both on the electrical transport and the noise properties: the total current is increased, while the levels of the GR noise components are decreased at the same time.