Label-free Detection of Mutation Genes with a Novel Side-gated NWFET

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There has been an increasing demand to find sensitive and rapid methods for the detection of specific nucleic acids sequences, which can also be used easily in nonspecialized laboratories. The detection of specific DNA sequences is of importance because more than 4000 inherited diseases are known, and much effort is needed to identify the mutations. The concept of using nanowire's field effect transistor (NWFET) for sensing the molecules has been proposed in recent year. However, most sensors are composed of a back gate[1], which limits the application of integration. In this paper, a new fabrication technique for the side-gated Si NWFET with the conventional LOCOS isolation process and electron-beam writing is proposed. By using the LOCOS process, the shrinking nanowire and individual side gate are achieved. This NWFET provides a good quality of SiO_2 gate dielectric, which exhibits lower leakage current and excellent field effect properties than the air dielectric[2].

These novel NWFET biosensors are used to detect the $BRAF^{V599E}$ mutation genes, which have been recently reported to be restricted to Papillary thyroid carcinomas (PTCs). The PTC is well known to a common endocrine malignancy of human cancer. It is reported that BRAF somatic missense mutations in 66% of malignant melanomas and at lower frequency in a wide range of human cancers. All mutations are within the kinase domain, with a single substitution (V599E) accounting for 80%.

The nano-channel defined by electron-beam writing and LOCOS oxidation on SOI wafer is illustrated in Fig. 1. Cross-sectional image illustrates the shrinking channel caused by the LOCOS "bird's beak". The immobilization and hybridization process are depicted in Fig. 2. The Vg-Id characteristic of the NWFETs illustrated in Fig. 3 exhibits about six orders of magnitude on I_{on}/I_{off}, and the threshold voltage shifts right to 4.2V after DNA immobilization. The excellent result suggests the nanodevice with a very sensitive probing capability. More results regarding the nanowire-based biosensors for mutation gene sensing will be presented in this conference.

[1]Z. Fan, D. Wang, P. C. Chang, W. Y. Tseng, and J. G. Lu, Appl. Phys. Lett. **85**, 5923 (2004).
[2]Y. Chen, X. Wang, S. Erramilli, P. Mohanty, and A. Kalinowski, Appl. Phys. Lett. **89**, 223512 (2006).

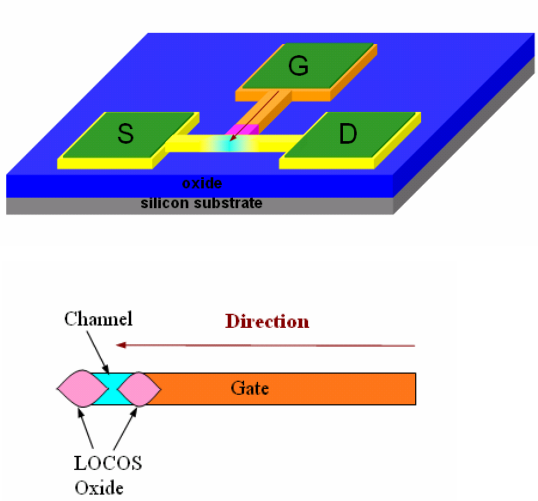

Figure 1. (a) The schematic diagram of side-gated NWFET, and (b) cross-sectional view of the cartoon of the NWFET.

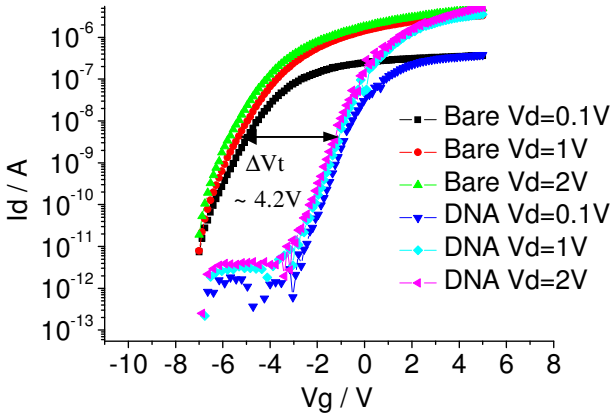

Figure 3. The Id-Vg characteristic of the side-gated NWFET before and after BRAF DNAs immobilization. The applied drain voltage is 0.1, 1, and 2V, respectively.

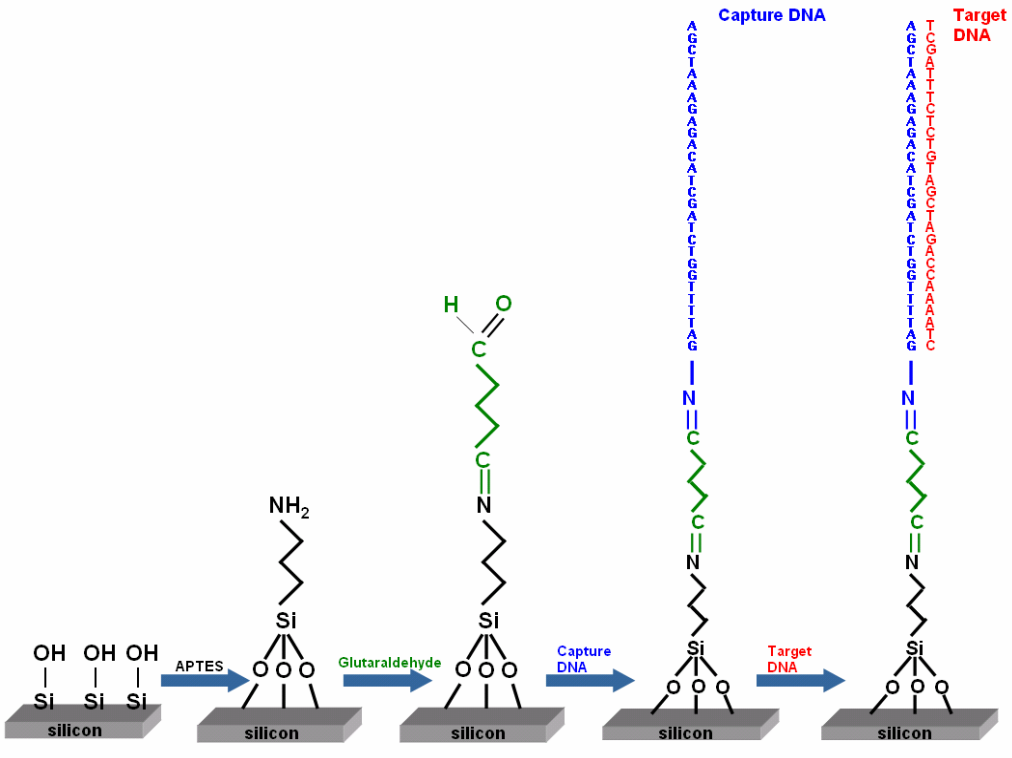

Figure 2. Various procedures for the immobilization of gene molecules onto the nanowire's FET.