Impact of Surface Cleaning on the DNA Immobilization Efficiency for Mutation Genes Detection

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Cancers arise owing to the accumulation of mutations in critical genes. Papillary thyroid carcinoma (PTC) is a common endocrine malignancy disease of human body. Molecular characterization of PTC may provide a characteristic for these tumours and may be useful for identification at the molecular level. The activation of point mutations for the *BRAF* genes has been recently reported to be restricted to PTCs. All mutations are within a single substitution (V599E) accounting for 80%. A thymine-to-adenine transversion is seen at nucleotide 1799 (T1799A).

In addition, with the developing of nano-technology, many advanced biological sensors, such as NWFWT (Nanowire's Field Effect Transistor), have received much attention due to many excellent characteristics. However, the conventional clean uses the well-known Piranha solution prior to immobilize the DNAs onto nanowire. But the Piranha clean may attack the metal contact of the NWFET. In this paper, various cleaning solutions for the immobilization efficiency of the $BRAF^{V599E}$ mutation genes on Si-OH substrate have been demonstrated. The fluorescent efficiency of DNAs immobilized on SiO_2 lines or trenches by various cleaning procedures are shown in Fig. 1. We find the sample after acetone/ethanol (ACE/EtOH) cleaning solution, as well as that of H_2SO_4/H_2O_2 solution, exhibits excellent immobilization efficiency. Therefore, immobilization with ACE/EtOH clean is implemented hereafter to substitute the conventional H_2SO_4/H_2O_2 solution. Figure 2 shows the structure diagram of the NWFET biosensor, which is fabricated on a SOI substrate and using the conventional MOS technology. The detection scheme of $BRAF^{V599E}$ mutation genes is illustrated in Fig. 3. The Vg-Id characteristics of the NW-biosensor before and after DNA immobilization are shown in Fig. 4(a). The threshold voltage (V_t) is shifted about +6V for biosensor after DNA binding. The significant shift in V_t suggests the high sensitivity of NWFET toward molecular detection. Figure 4(b) also illustrates the statistical distribution (n=10) of V_t shift. The reproducible results in V_t shift ensure the reliability of our bio-sensing system by NWFET. More results on biosensor properties will be presented in the conference.

1. H. Davies et. al., Nature, Vol. 417, 2002, pp. 949-954.
2. F. Patolsky and C.M. Lieber, Materials Today, Vol. 8, 2005, pp. 20-28.

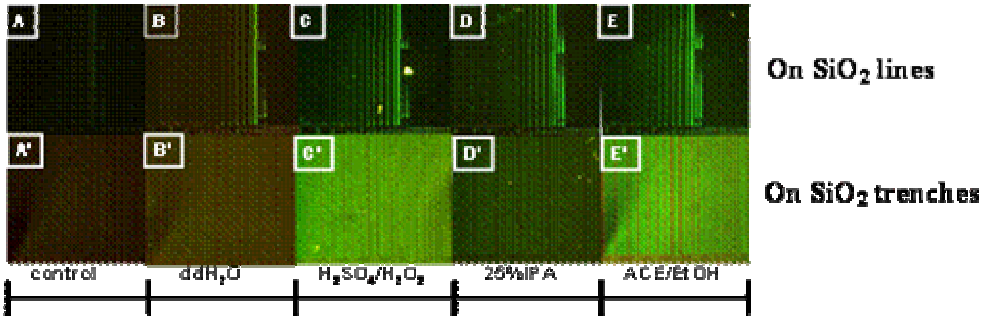

FIG.1. Fluorescent images for DNA immobilization after four cleaning solutions. (A) control (without cleaning Process), (B) ddH_2O, (C) Piranha solution, (D) 25% IPA, and (E) acetone/EtOH

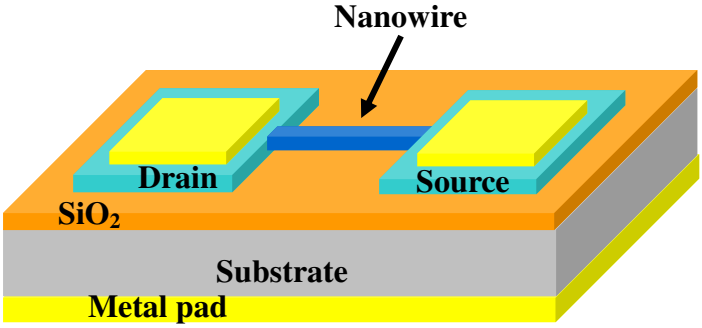

FIG.2. 3D schematic diagram for the NWFET structure.

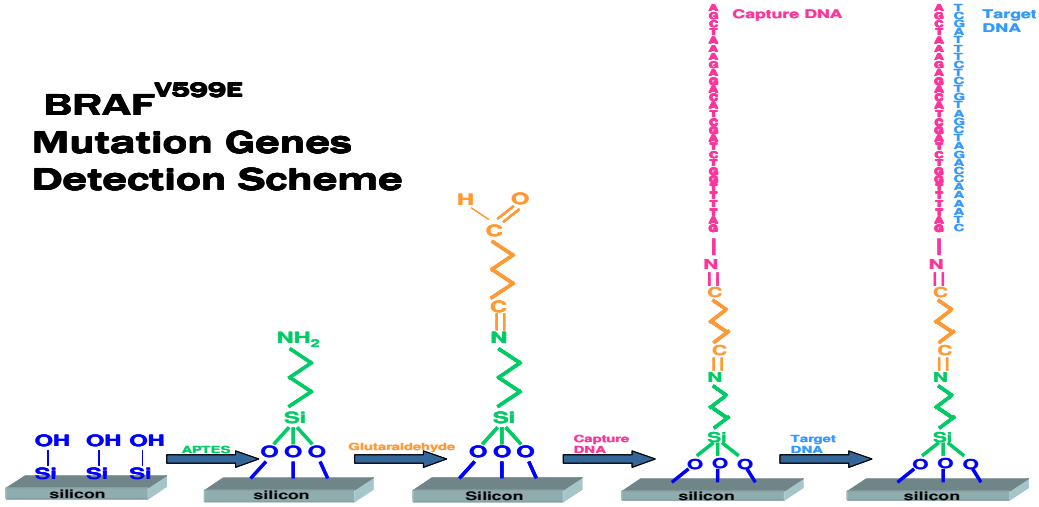

FIG.3. The diagram of detection scheme for $BRAF^{V599E}$ mutation genes.

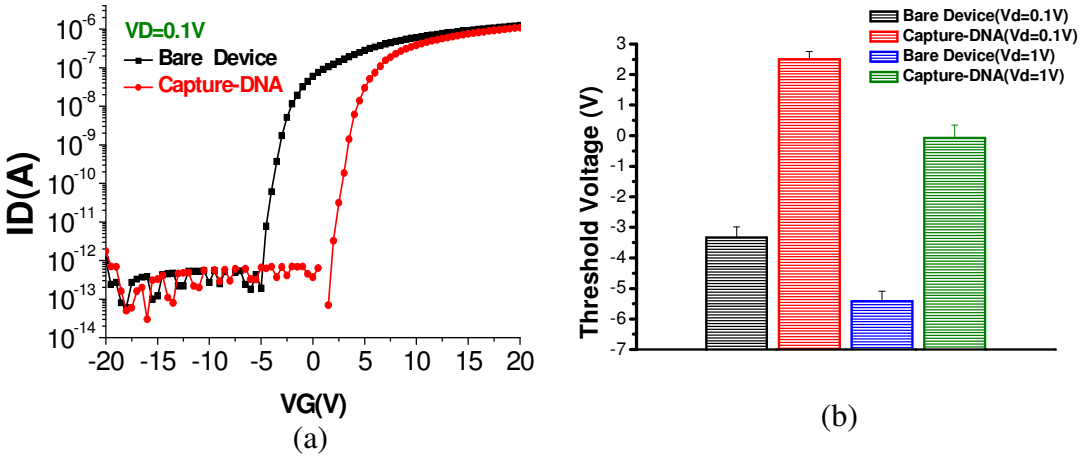

FIG.4. (a) Vg-Id characteristics of the NWFET before and after DNA immobilization, and (b) statistical distribution of sequential reduction in V_T for the NWFET biosensor.