

## **Supplementary Information**

### **Self-Amplified Transistor Immunosensor under Dual Gate Operation: Highly Sensitive Detection of Hepatitis B Surface Antigen**

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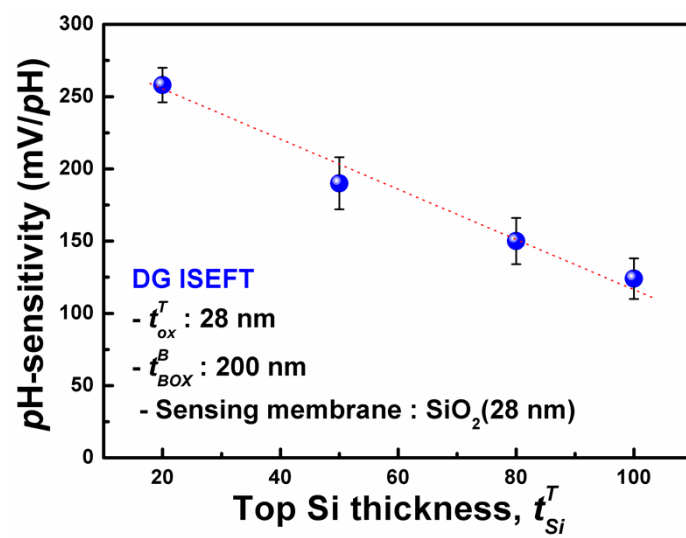
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## Materials preparation

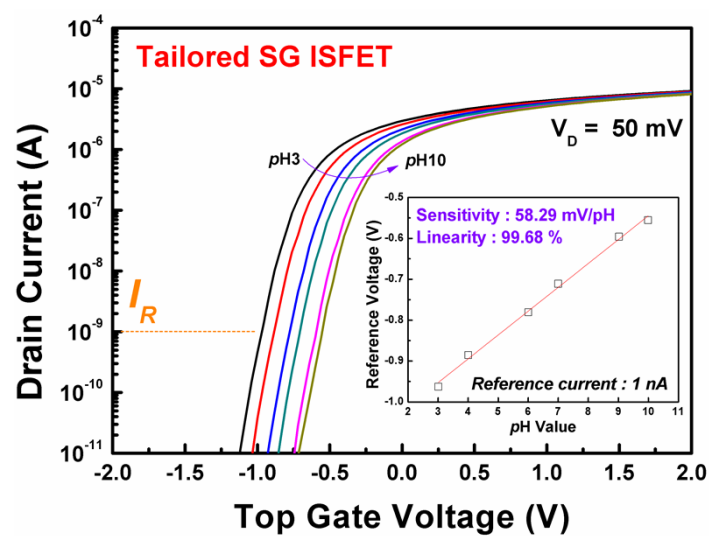
- Chemicals: 3-aminopropyltriethoxysilane (APTES), succinic anhydride, n,n-dimethylformamide (DMF), bovine serum albumin (BSA), 1-Ethyl-3-(3-dimethylaminopropyl) carbodiimide hydrochloride (EDC), and N-hydroxysuccinimide (NHS) were purchased from Sigma Aldrich (USA) to conjugate the HBs antibodies (anti-HBsAg) on the sensing membrane. The 1× PBS (pH 7.4) was obtained from GIBCO (USA) and used as a buffer solution. The PBS solution was composed of 155 mM NaCl, 1 mM  $\text{KH}_2\text{PO}_4$ , 3 mM sodium phosphate buffer, and deionized (DI) water. The DI water was obtained from the reverse osmosis water system (Human Science Co., Korea).
- Proteins: Monoclonal anti-HBsAg (clone 1) and recombinant HBsAg proteins were purchased from Healthcare Bio Innovation (HBI Co., Korea, catalogue number: MAB-0102 and RPB-0401).

### **Surface functionalization and anti-HBsAg immobilization**

- The sensing membrane ( $\text{SnO}_2$ ) was cleaned with acetone and methanol solution, respectively, for 10 min and rinsed with DI water for 10 min to remove the organic contaminations. In order to form hydroxyl groups on the surface, the oxygen plasma treatment was carried out using a RIE system. Then, a 5% ethanol solution of APTES was injected onto the surface and maintained for 1 h at room temperature to functionalize the sensing membrane surface with amine groups. After washing out unreacted APTES with ethanol, the surface was rinsed with DI water and dried in nitrogen gas, and baked for 30 min at 120 °C on a hotplate. A solution containing succinic anhydride and DMF was injected onto the surface and incubated for 12 h at 37 °C to expose the carboxyl group. After that process, the surface was activated with EDC (0.4 M) and NHS (0.1 M). To immobilize the anti-HBsAg, the surface was immersed into a PBS (pH 7.4; 1×) buffer solution containing 150 nM (2.25 µg/mL) of anti-HBsAg and maintained for 1 h at 27 °C for 1 h. The un-reacted sites on the surface were blocked using ethanolamine and BSA to avoid non-specific binding.

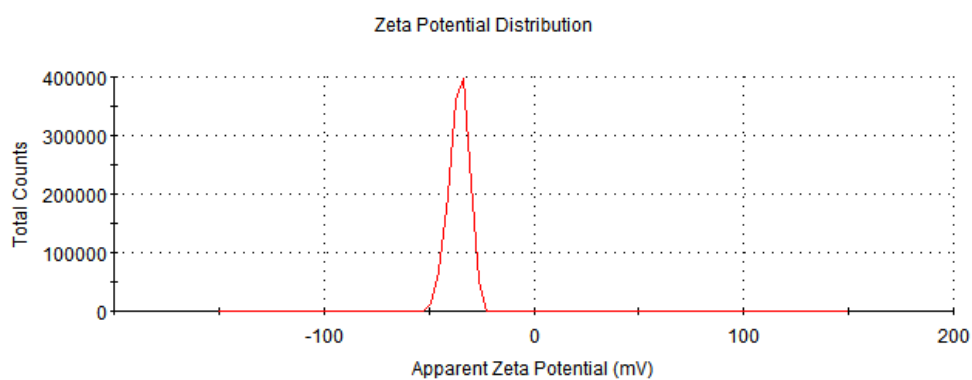


**ESI Fig. S1†.** pH-sensitivity of DG ISFETs depending on the thickness of top silicon.



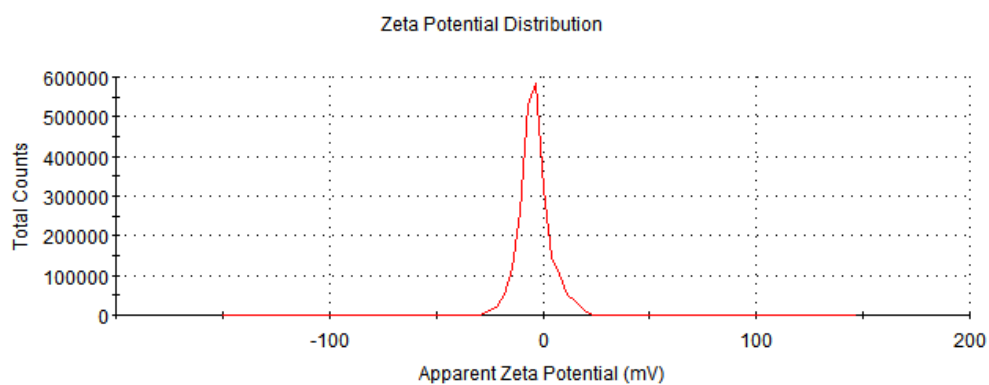
**ESI Fig. S2†.**  $I_D$ – $V_G$  curves of the SG ISFET with tailored TFT (tailored SG ISFET) for different pH buffer solutions. The drain bias is set at 50 mV. The response voltage ( $V_R$ ) for each pH buffer solution, shown in the inset, was defined as the corresponding gate voltage to the drain current (reference current:  $I_R$ ) of 1 nA.

(a) HBsAg



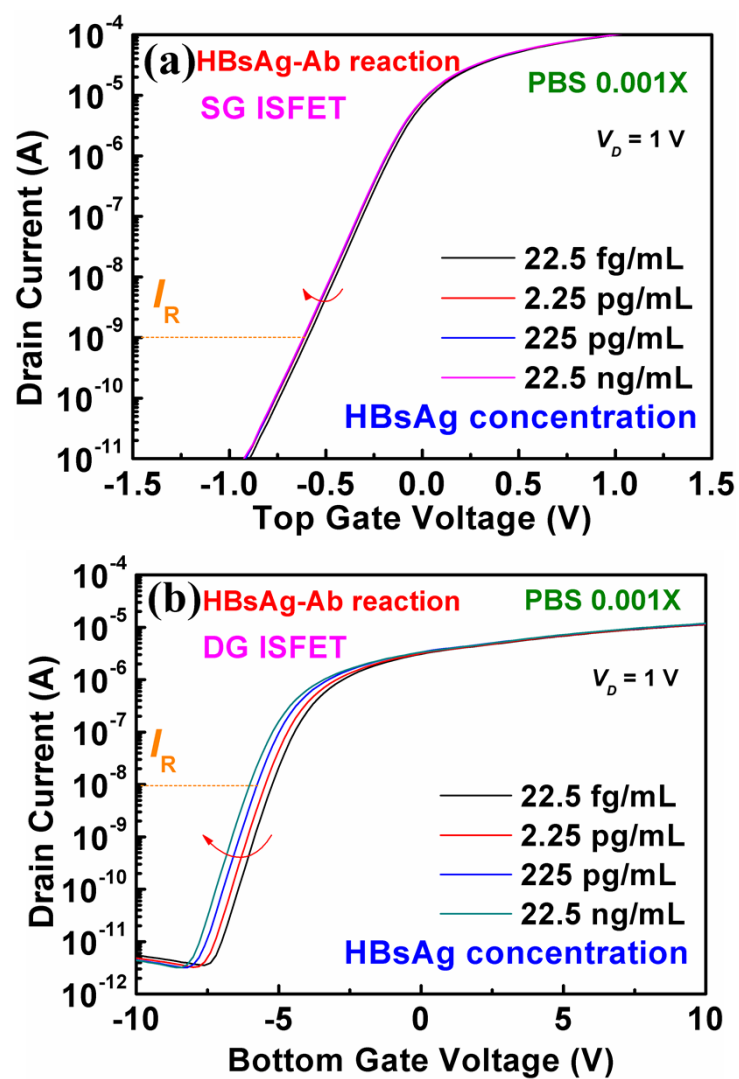
**<Mean zeta potential: -35.7 mV>**

(b) Anti-HBsAg



**<Mean zeta potential: -3.96 mV>**

**ESI Fig. S3†.** Zeta potential distributions for (a)HBsAg and (b)anti-HBsAg, respectively.



**ESI Fig. S4†.**  $I_D$ - $V_G$  curves of the (a) SG and (b) DG ISFET with non-tailored TFT according to HBsAg concentration in HBsAg-Ab reaction