Analysis and modeling on the pH-dependent current drift of Si nanowire ion-sensitive field effect transistor (ISFET)-based biosensors

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Although the ion-sensitive field effect transistor (ISFET)-based biosensor has a great potential for point-of-care testing systems, the current drift still remains as a challenging issue for its commercialization [1]. Furthermore, the drift makes the design of readout circuit for a high-resolution biosensor very complicated because it is sensitive to the amount of ionic species in electrolyte or human serum [2]. However, its chemical/physical origin is neither yet fully understood nor modeled for the circuit design and simulation. In this work, the pH-dependence of drift in the top-down processed Si nanowire (SiNW) ISFET [3] [Fig. 1(a)] is investigated and modeled for its robust circuit analysis.

Doubly swept transfer curves in SiNW ISFETs show that the hysteresis increases with the decrease of pH value both in a subthreshold and in a GIDL region [Fig. 1(b)]. The current drift also becomes more severe with the decrease of pH value [Fig. 1(c)]. Based on experimental results, the chemical/physical origin on drift will be analyzed and modeled. Furthermore, the procedure of extracting model parameters will be shown. Our result is potentially useful for the drift-aware circuit design for a high-resolution biosensor system.

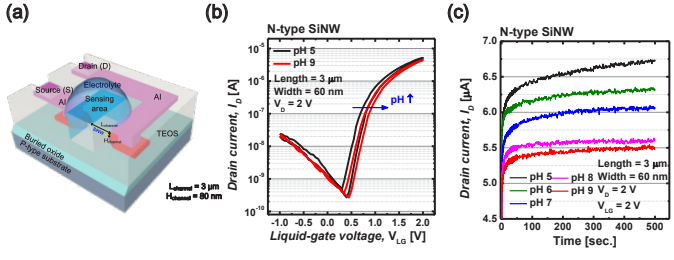

Fig 1. (a) Bird's-eye view of the fabricated SiNW ISFET biosensor. (b) Doubly swept transfer curves and (c) the current drift characteristics in various pH conditions.

Reference: [1] J. H. Lee, *Ph.D. dissertation, Dept. of Electric and Computer Engineering, Seoul National University*, 2014. [2] S. Jamasb, IEEE Sensors Journal **4** (6) p. 795 (2004). [3] J. Lee et al., IEEE International Electron Devices Meeting 385 (2013).
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