An accurate and efficient simulation technique for FET-type biosensors

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There is growing interest in the application of electrolyte-insulator-semiconductor field-effect transistor (EISFET) to the electronic sensing of biomolecules [1]. This study presents a novel simulation method for EISFET in electronic biomolecule sensing application. The proposed method considers the fact that the ionic solution, i.e., the electrolyte, can be defined as an emulated intrinsic semiconductor material for the realization of FET-type biosensors, using a well-established commercial semiconductor 3D TCAD simulator. The proposed simulation method employs the Gouy-Chapman-Stern model [1] of the electrical double layer as well as an effective ionic concentration in a real ionic solution. The simulation results ensure that the Debye length obtained from the simulation corresponds well with the calculated Debye length. Furthermore, the application of the simulation method to pH sensors is successfully demonstrated by incorporating the site-binding model [1-2]. Therefore, the proposed method is able to simulate any type of FET-type biosensor and can be utilized to predict the optimal sensor performance.

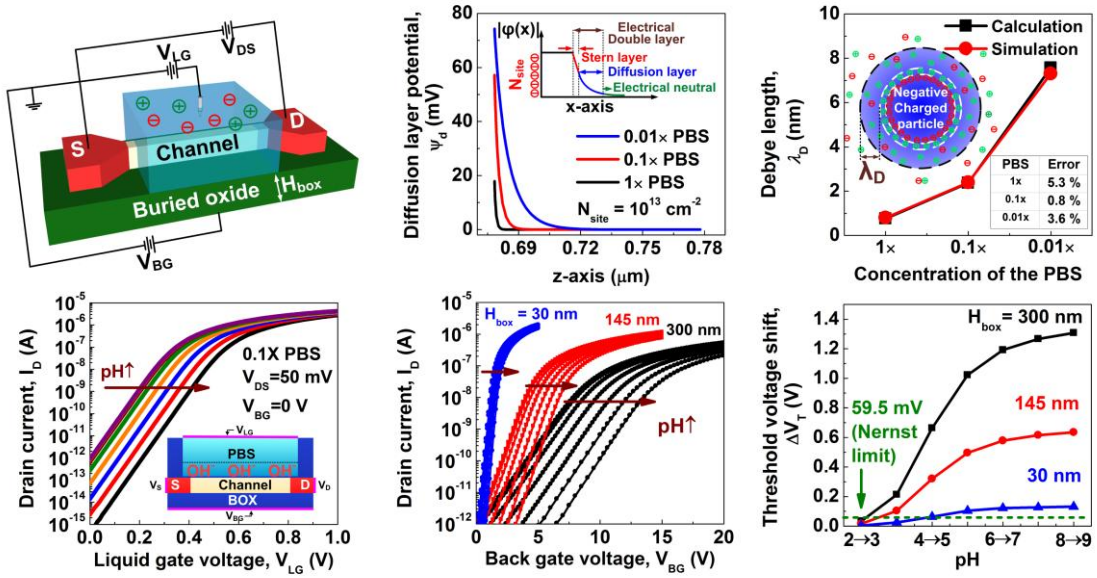

Fig 1. 3D biosensor device and its electrical data under pH and PBS concentrations

[1] M. W. Shinwari, M. J. Deen and D. Landheer, Microelectron. Reliab. 47, 12 (2007).
[2] S. Chen, J. G. Bomer, E. T. Carlen and A. van den Berg, Nano Lett. 11, 6 (2011).