Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Size effect of silicon nanowires on their pH response SEONGJAE LEE, IN-BOK BAEK, XIANHONG LI, Hanyang University — The silicon nanowire is a promising material for the bio-chemical electronic sensors because the local change in the surface charge density can be easily transduced to the conductivity change of the nanowire due to its high surface-to-volume ratio. We investigated the pH-dependent electronic transport characteristics of FETs comprised of silicon nanowire channels of different sizes. Starting from the p-type SOI wafer with the top silicon layer of 40 nm thickness, we employed the conventional 'top-down' process to fabricate the FET devices with various silicon nanowires: 100, 135, 180, 220, 300 nm in width and 2, 5, 10, 20 μm in length. The devices were electrochemically characterized by I_D-V_G measurements with a reference electrode as a gate in the phosphate buffer solutions of a pH value ranging from 2 to11. The threshold voltages of all devices were extracted from the I_D-V_G curves and their relations to pH were compared with simulation results based on the Gouy-Chapman-Stern-Graham model. A good linear relation between the threshold voltage and pH was observed for all devices in the range of $4 <$ pH $<$11 with a high sensitivity of 56 mV/pH which is much higher than the bulk devices and very close to the Nernst limit. However, the systematic increase of a threshold voltage shift as decreasing nanowire's dimension (width and length) was also observed and possible origins are discussed within the scope of the Gouy-Chapman-Stern-Graham model.

Seongjae Lee
Hanyang University

Date submitted: 14 Dec 2010 Electronic form version 1.4