Short bio

Per-Erik Hellström (Hellberg) was born in Stockholm, Sweden in 1970. He received the M.Sc. and Ph.D. degrees in electrical engineering from KTH Royal Institute of Technology, Stockholm, Sweden, in 1995 and 2000, respectively. His Ph.D. thesis dealt with polycrystalline $Si_{1-x}Ge_x$ as gate material for CMOS technology. Since 2000, he has been a Research Associate at KTH School of Electrical Engineering and Computer Scinece and in 2006 he was appointed Docent. He is currently managing the Si and SiC process technology line at KTH's Electrum Laboratory. He has coauthored more than 100 papers in refereed journals and conference proceedings. His current research interests include semiconductor process technology, advanced nano-scaled MOSFETs, monolithic 3D integration technology and devices for sensing applications.

Abstract

Wafer scale fabrication and characterization of HfO2 integrated silicon nanowire biosensor for DNA sensing application.

Silicon nanowire (SiNW) charge based biosensors are attractive for DNA sensing applications due to their compactness and large surface to volume ratio. Small feature size, budget friendly production cost, high sensitivity and selectivity to only a particular target of interest and repeatability are some of the key requirements of a SiNW biosensor. The most common e-beam manufacturing method employed to manufacture sub-nm SiNW is both cost and time intensive. Therefore, we propose a CMOS industry grade low cost process to fabricate SiNW. The 60 nm wide SiNW reported in this paper is fabricated using sidewall transfer lithography process (STL). STL is a self-aligned-double-patterning I-line lithography process that also facilitates HfO2 integration on top of the SiNW. The SiNW surface is encapsulated with a thin layer of 4.5 nm HfO2 on which DNA probes were grafted. HfO2 was chosen contrary to employing the classical SiO2 on the surface of the SiNW because it has been reported to have higher density of –OH groups on the surface. The higher amount of –OH groups on the SiNW surface leads to enhanced sensitivity. The functionalization process of the HfO2 covered SiNWs was carried out via a silanization step using an aminosilane followed by covalent grafting of single strand DNA probes. The efficiency of this process could be validated optically performing DNA hybridization with complementary fluorescent DNA targets. In order to emphasize the electrical response of the sensor to DNA hybridization, the I_D-V_{BG} characteristics were measured after each of these steps. After each step, SiNW devices exhibited systematic threshold voltage shift larger than the noise introduced by the exposition to the saline solution used for DNA grafting and hybridization, showing that both grafting and complementary DNA hybridization can be electrically detected. More specifically, we demonstrate that 85% of the tested devices exhibit a positive shift in threshold voltage after DNA hybridization. These promising results make way for the fabrication of a point of care (POC) device employing SiNW biosensor and CMOS circuitry that can offer reliable real time electrical readout.