Fabrication and Particular Applications of Group IV Semiconductor Nanowires

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During the last 1-2 decades semiconductor nanowires (NWs) have received significant academic and commercial attention due to their attractive electrical and mechanical properties and large surface area to volume ratios. They have a variety of possible applications including nanoelectronics, nanophotonics, photovoltaics, sensorics, etc. Among all semiconductor NWs the ones based on group IV materials have the advantage of being the most silicon (Si) compatible. This is very important since their integration into the existing semiconductor technology platform can be relatively easy.

We will give a general overview of our activities on group IV nanowires. We will first present the NWs that we are working with, including top-down fabricated Si and germanium (Ge) NWs having widths down to 6-7 nm as well as bottom-up grown alloyed germanium-tin (Ge1-xSnx) NWs with x = 0.07-0.1, diameters of 50-70 nm and lengths of 1 to 3 m. We are currently working also on the fabrication of alloyed SiGe and SiGeSn NWs with varying content of the different materials.

Next, we will discuss the innovative nanoelectronic devices that we are working on, namely junctionless nanowire transistors (JNTs) and reconfigurable field effect transistors (RFETs). In particular, we are fabricating Si JNTs for sensing application as well as Ge and GeSn JNTs for digital logic. Concerning RFETs, we are currently working on Si RFETs and commencing activities on SiGe and GeSn RFETs, which are expected to outperform the Si RFETs.

Finally, we will briefly present a novel device concept that we recently invented: a specific group IV heterostructure band-to-band tunnel FET (TFET). The fabrication process of this device is scalable and fully CMOS compatible

and should allow the achievement of high on-current Ion together with low off-current Ioff, hence steep subthreshold slope.