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Application of Atom Probe on Fully Depleted Silicon-On-Insulator (FDSOI) Structures

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The transistor device structures are rapidly scaling down to the nanometer regime, with the ongoing development in semiconductor device technology to reduce power consumption and to increase performance, able to do more useful important and valuable things as faster as possible. Present days the device structure has shrunk to a size below to few nanometers, which increases the challenges for every new generation of technology. To deliver higher performance while keeping limitations in control bulk silicon transistors are become more complex by adding additional manufacturing steps will become more expensive. The new innovations in process technology called Fully Depleted Silicon On Insulator (FDSOI) [1] is a planar process technology that delivers the benefits of the reduced silicon dimensions while simplifying the manufacturing process. This technology unfolds many different analogue and radio-frequency (RF) applications due to its unique capability [2]. FDSOI relies on a thin layer of silicon over a Buried Oxide layer. Transistors built into this top silicon layer are Ultra-Thin body devices and have unique, extremely attractive characteristics.

Recently atom probe tomography (APT) has shown its capability to analyze semiconductors devices applications with elemental accuracy [3&4]. The analysis of FDSOI structures by APT is typically challenged as the structures relied on insulator, along with presence of various other gate stack materials. In this paper we will present the atom probe analysis of FDSOI structures to extract the elemental information. Figure 1 shows the transmission electron microscope (TEM) image of the structure along with APT atomic mapping of different elements presents in the analyzed volume. Figure 2 provides the information of elemental profiles extracted at different directions to understand the distribution of elements. The profile on Gate, provides the concentration of gate stack (TiN/HfO) above the channel. The profile through Source/Drain (S/D) provides the information of dopant (boron) and SiGe distribution in sigma shaped structure, while the profile through S/D and channel provides the information of how much dopant (boron) is under diffused from the S/D into the channel and the variation in the Ge concentration.

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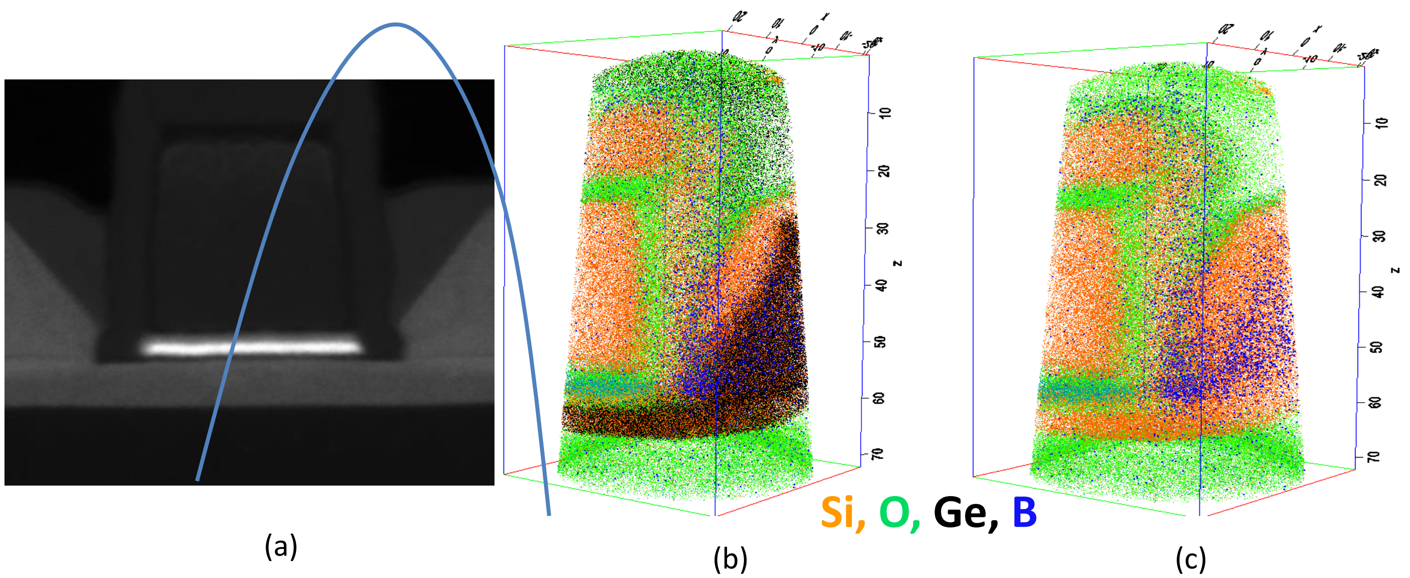

Figure 1. TEM Image of FDSOI Structure, the marked lined is APT analysis volume. (b&c) The atomic mapping of elements present in the analyzed volume.

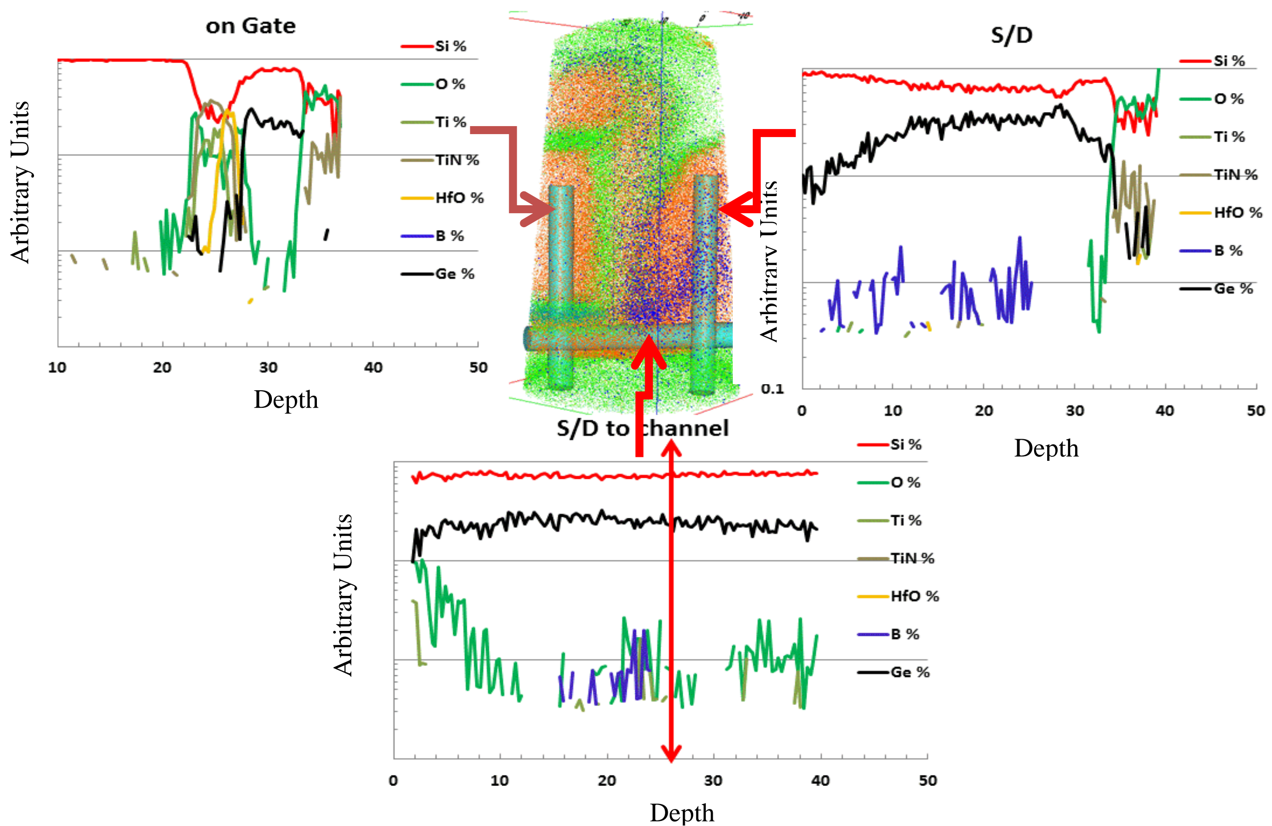

Figure 2. Elemental Profile extracted from all directions on Gate, Source/Drain and in the channel of the APT analyzed volume.

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