3D Condensation of SiGe for Fabricating High Quality (110)-Oriented Nano-patterns of GOI for augmented MOSFETs based devices

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The fabrication of Ge strained (and/or unstrained) layers or nanolayers embedded in an oxide layer has attracted great deal of attention for various applications such as photodetectors, resonant tunneling devices, transistors, etc. In this work, we demonstrate the integration with silicon of fully relaxed Ge-on-insulator nanolayers enabled using the combination of epitaxy / condensation and patterning. Arrays of nano-patterns of extremely thin, rectangular-shaped strips of high-quality Germanium on insulator (GOI) are fabricated for use in augmented Metal-Oxide-Semiconductor field-effect transistors (MOSFET) based devices. The process involves the epitaxy of low concentration SiGe alloy. After growth, arrays of submicron-wide stripes with various rectangular shapes are patterned on the SOI/SiGe. Subsequently, the patterned wafer is introduced into an industrial dry oxidation furnace to perform the condensation which consists of the selective oxidation of Si associated to the repulsion of Ge atoms at the bottom of the layer resulting in 3D condensation. This process is engineered to consume all the Si atoms contained in the SOI/SiGe layers to generate high crystal quality GOI nanolayers with thicknesses about 3-4 nm. The resulting GOI nanolayers have great potential for augmented MOSFET based devices, since Ge mobility far exceeds Si mobility. In addition, when the GOI becomes thinner, there is a noticeable increase of the mobility due to the quantum confinement (modulation of the GOI band).

In this study we show that a sliding behaviour of the GOI/BOX interface, due to weak bonds between the two layers can relieve mechanical stress in the Ge-rich layer. Such behaviour enables the creation of defect-free pure Ge nanolayers. In addition, the process allows the fabrication of well organised arrays of Ge nanodots embedded in the oxide layers. These nano-objects are well suited for resonant devices.