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Strained, Nanometer-thin Single Crystal Silicon Layers Produced by Thermal Crystallization of a-Si/a-SiO_2 Superlattices

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Current trends in the development of information technology clear show that portable, inexpensive devices combining capabilities of personal digital assistants (PDA) and mobile wireless devices (cellular phones, GPS, etc.) most likely will be the key product in very near future. Despite strong domination of single crystal Si based technology in the current electron device market, manufacturers begin to understand many strong advantages of nanostructured materials for low power, high-speed devices. These advantages include band structure engineering in nanometer-thin, strained Si layers. It is well known that the strain in c-Si may split the conduction band Δ valleys in energy with 4 valleys being lowered and 2 raised in energy. The two hole bands may become non-degenerate at the Δ-point as strain is applied and the spin-orbit band is reduced in energy, producing additional spectroscopic features.

So far, strained Si has been grown on substrates with a combination of strained and relaxed SiGe layers. In this presentation, we report the first fabrication of strained, nanometer-thin, single crystal Si layers produced by controlled thermal crystallization of 20 nm a-Si layer sandwiched between layers of a-SiO_2 with thickness of 30 nm [1]. Transmission Electron Microscopy (TEM) and photoluminescence measurements reveal the single crystal structure of 20 nm thick Si layer with several unusual spectroscopic features (Fig. 1) currently attributed to the strain-induced band-structure modification. Additional measurements are focused on carrier transport and potential device application will be discussed.

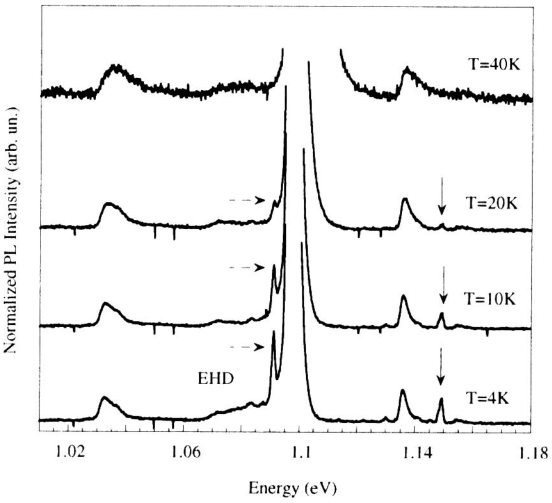

Figure 1. Photoluminescence spectra of strained Si layers at different temperatures showing unexpected spectroscopic features at 1.144 eV and 1.091 eV with the identical temperature dependence. The observed peaks are associated with the strain-induced modification of Si band structure.

References

B. Kamenev and L. Tsybeskov, APL in press.