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*Enhancing performance of modern MOSFETs: strain engineering and advanced device architectures.*

The breathtaking increase in computer performance is due to the scalability of MOSFETs. The scaling theory has so far guaranteed an increase in transistor performance for each generation, and almost no changes have been required in the transistor design until recently. However, with the 65 nm technology node in production, it becomes difficult to maintain the projected 30% performance gain per generation while keeping the device leakage small. Novel device and material engineering solutions must supplement the conventional scaling in order to meet the projected target performance gain. Several options are available. New device architectures based on use of silicon-on-insulator (SOI) technology and multi-gate structures allow to reduce the short channel effect. The second option is mobility enhancement through stress and alternative substrate materials. Accurate transport modeling in SOI FETs for arbitrary substrate orientations and general stress conditions becomes an important issue because it helps to reduce technology-development costs.
After a brief outline of transport modeling in MOSFETs, we highlight the influence of degeneracy effects and intersubband scattering on electron mobility in single- and double-gate SOI FETs for different crystal orientations of thin silicon body. Special attention will be paid to technologically relevant stress in [110] direction. The [110] stress produces off-diagonal elements of the strain tensor, which induce pronounced modification of the Si conduction band. We derive analytical expressions for both

transversal and longitudinal masses stress dependences and valley shifts. These analytical results are verified against pseudo-potential band structure calculations and excellent agreement is found. The electron mobility enhancement in the direction of tensile [110] stress is due to the conductivity mass modification and is shown to exist in SOI FETs with arbitrary small body thickness.