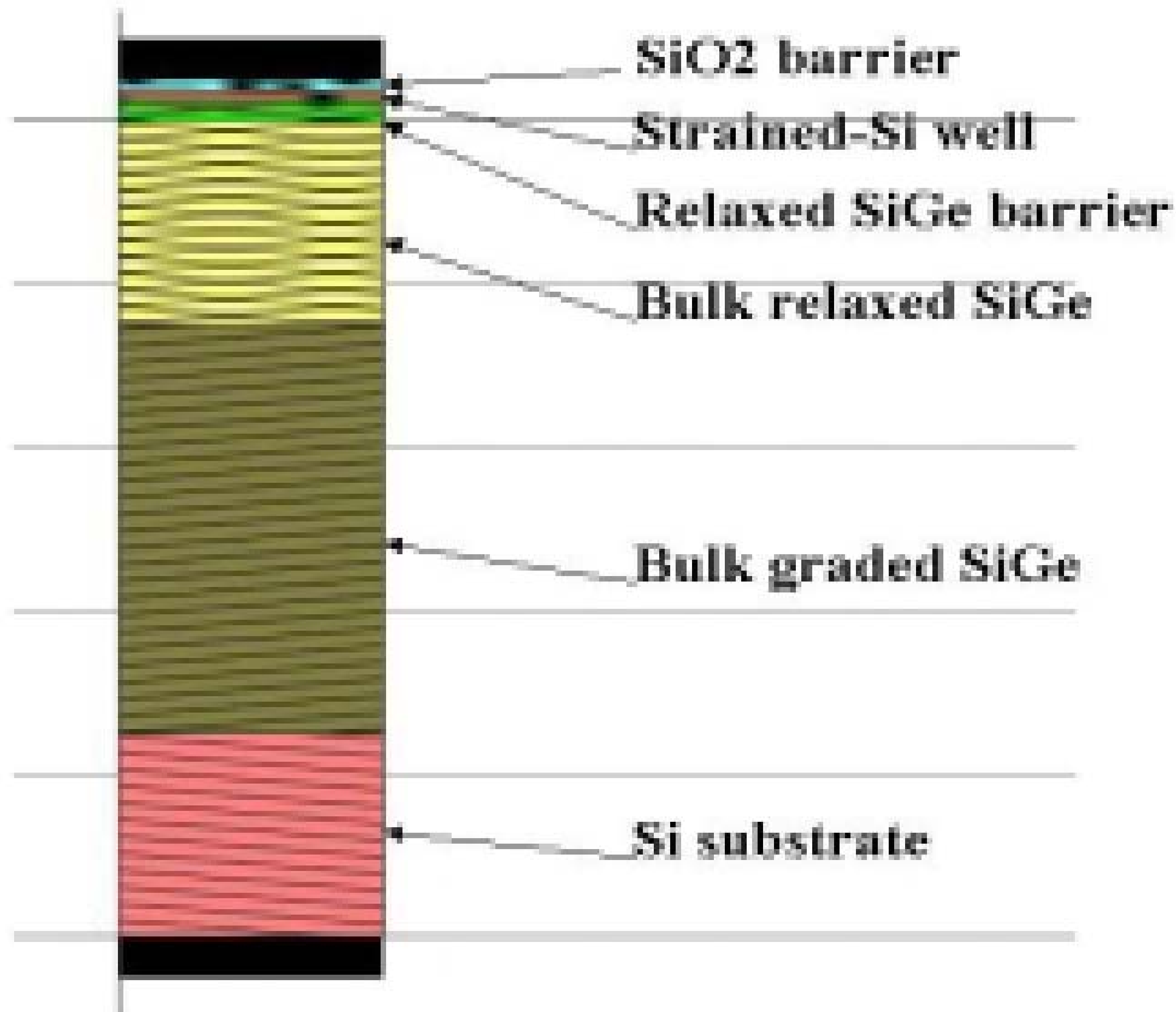


Schematic of Si quantum well channel on relaxed SiGe

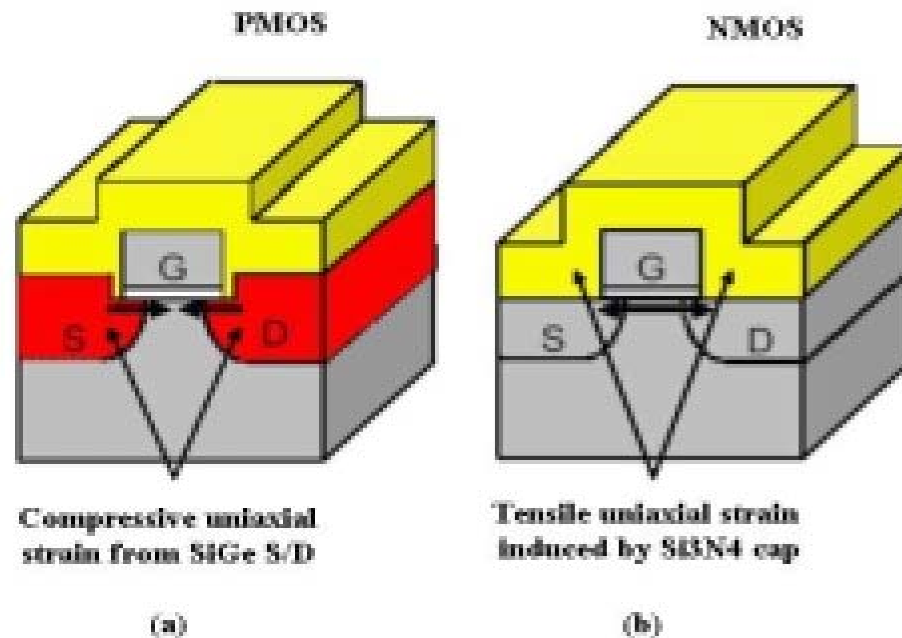


Figure 1.13: Schematics of PMOS and NMOS structure with uniaxial strains considered in this chapter.

Strained Silicon-Basic Theory

To create a semi-empirical mobility model with reasonable quantum physics and few fitting parameters→ Good engineering approach: Crosslight's valley-dependent quantum subband averaged mobility model (3-parameter model):

Basic Theory:

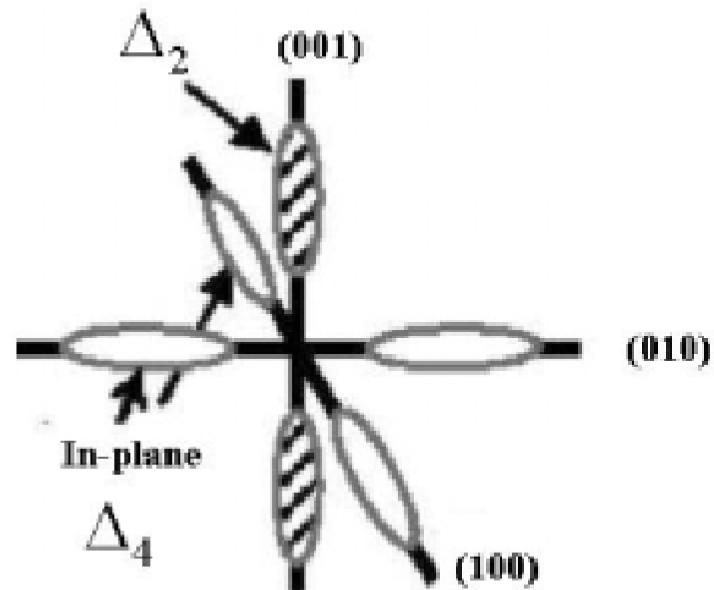
1) Valley dependent bulk mobility averaged over valley subbands in quantized states.

2) Valley dependent bulk mobility: Acoustic-phonon intravalley scattering dominant for electron and both intravalley and Intervalley phonon scattering for holes.

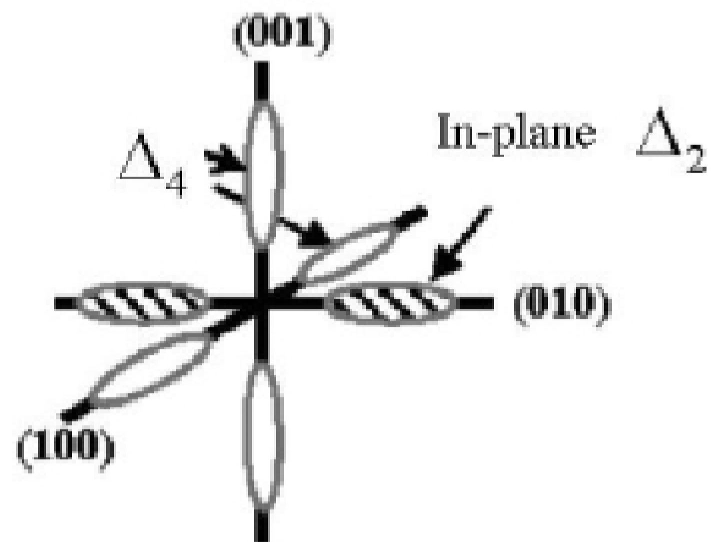
Bulk mobility:

$$\mu_{ac} = \frac{2^{3/2}\sqrt{\pi}\hbar^4 \rho v_s^2}{3m^{*5/2} D_{ac}^2 (k_B T)^{3/2}}$$

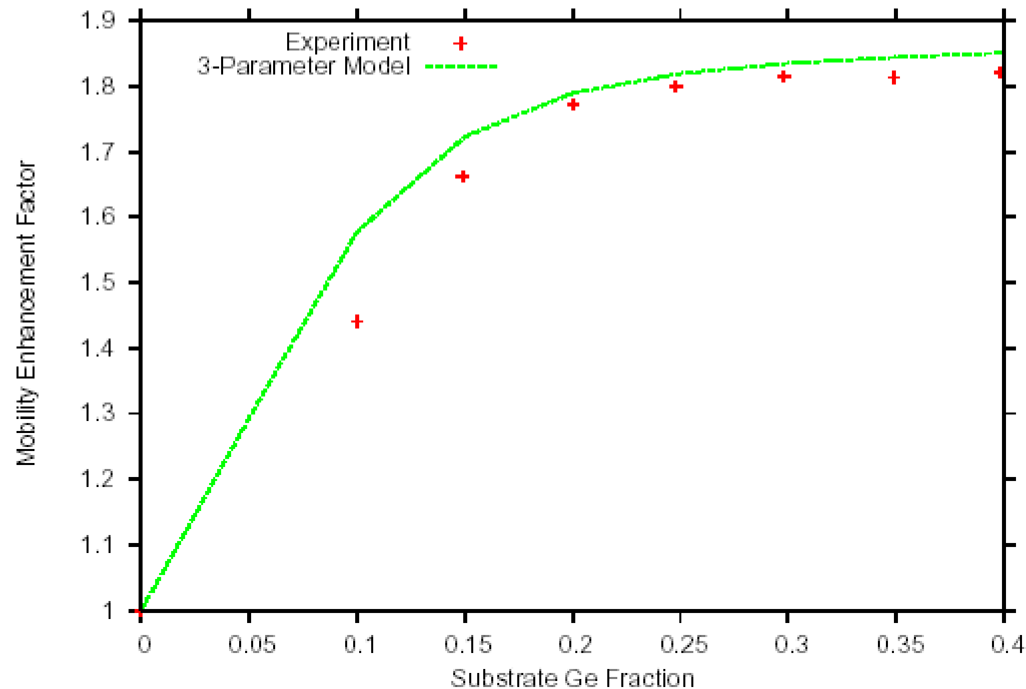
$$\mu_{op} = \frac{4\sqrt{2\pi} e\hbar^2 \rho sqrt \hbar\omega_0}{3m_d^{*3/2} m^* D_{op}^2} f(x_0)$$



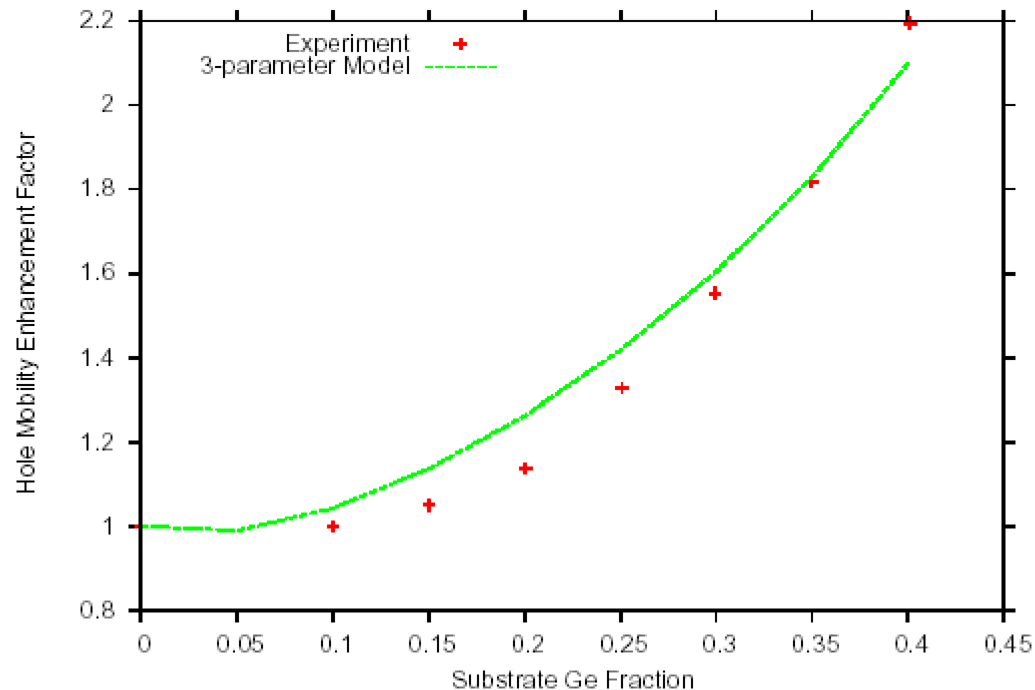
Schematics of conduction band valleys of silicon under biaxial in-plane stress.



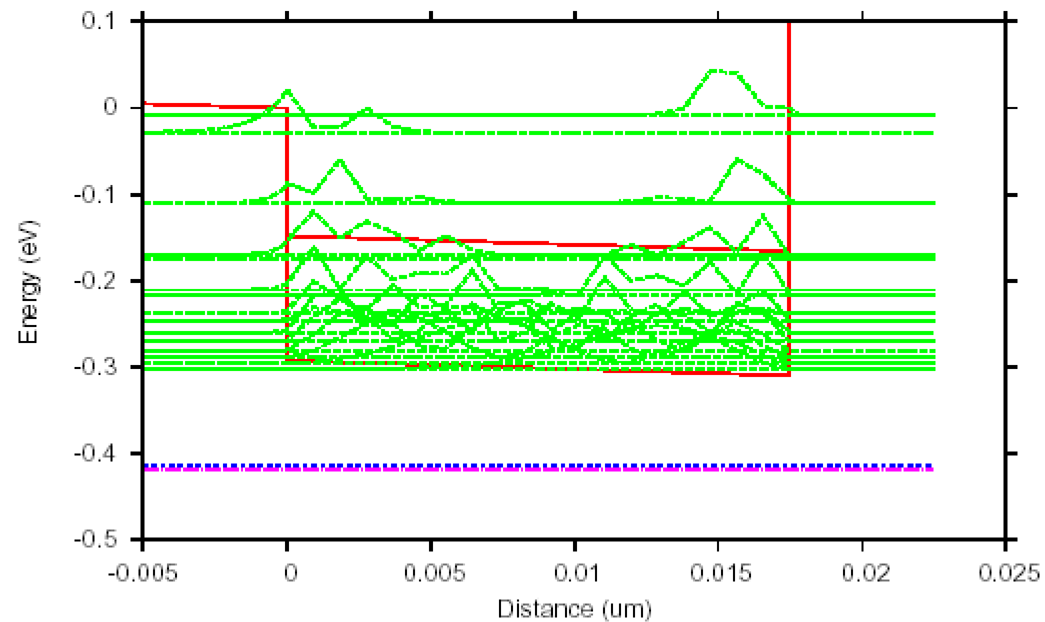
Schematics of conduction band valleys of silicon under uniaxial in-plane stress.



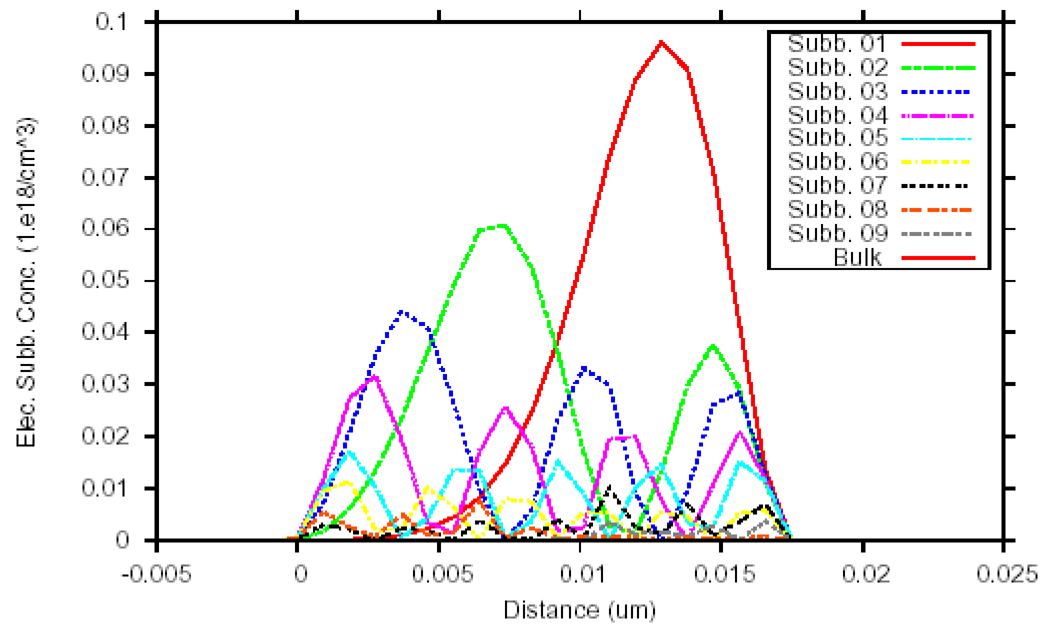
Comparison with experiment for Crosslight's 3-parameter mobility model averaged over valley densities in a typical n-MOSFET quantum well.



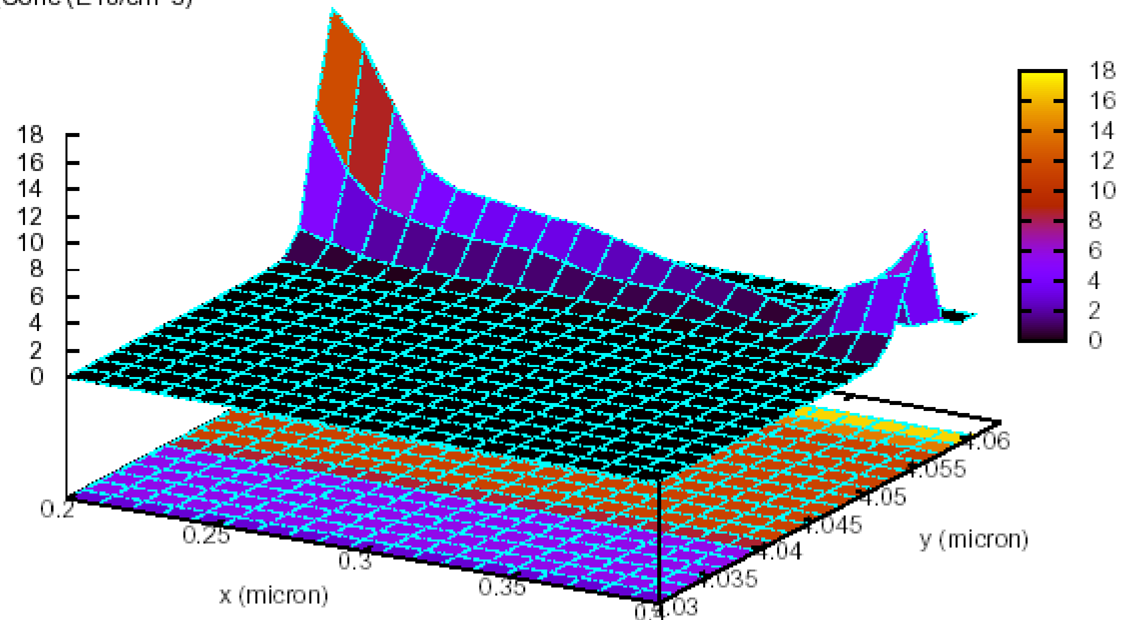
Comparison with experiment for Crosslight's 3-parameter mobility model averaged over valley densities in a typical p-MOSFET quantum well.



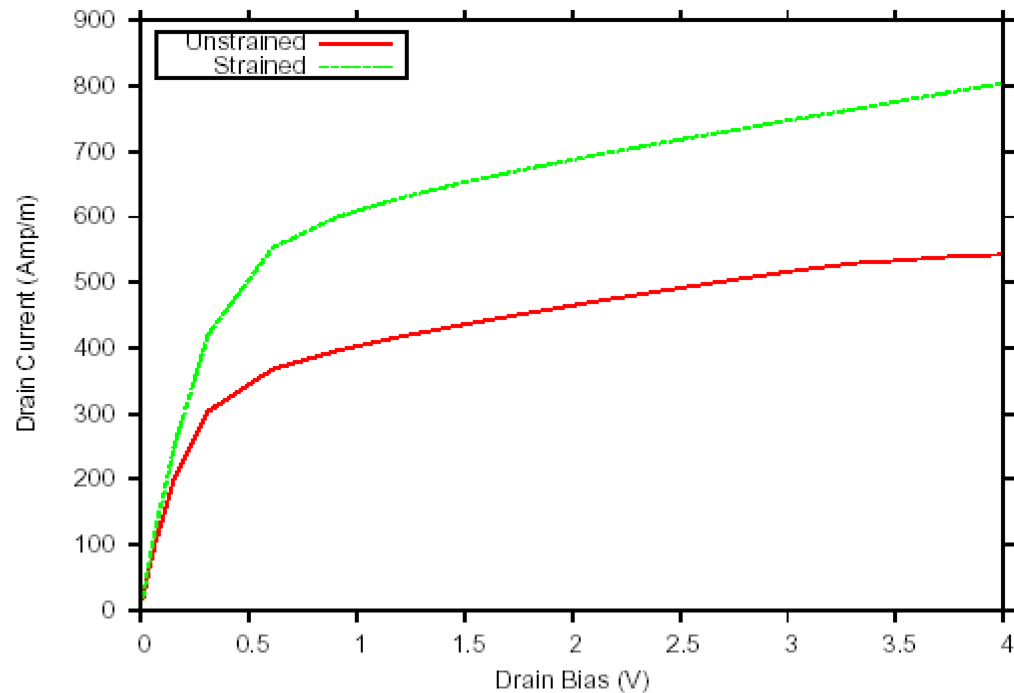
Band structure and quantized states in Si/SiGe with 30 percent Ge plotted for the lower conduction band valley.



Subband concentration distribution for Si/SiGe with 30 percent Ge plotted for the lower conduction band valley.



2D distribution of subband concentration plotted for the lower conduction valley. Structure is Si/relaxed-SiGe with 30 percent Ge.



Comparison of Id-Vd characteristics of unstrained structure with uni-axially strained Si PMOS. Gate voltage is set at -1 volt.

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