Task 6.1: Role of alloy scattering in strained SiGe nano MOSFETs

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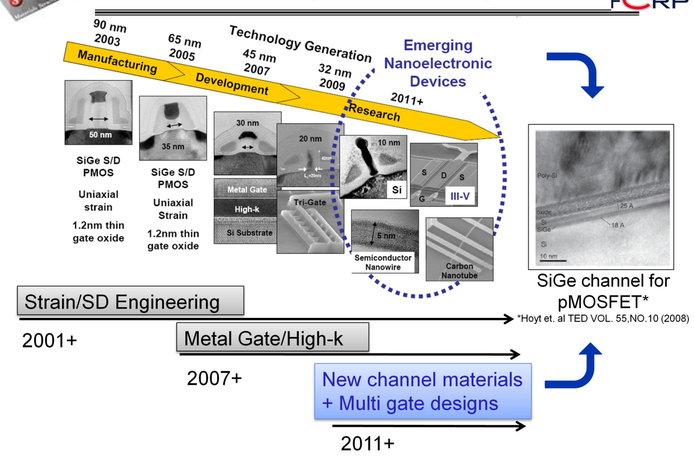
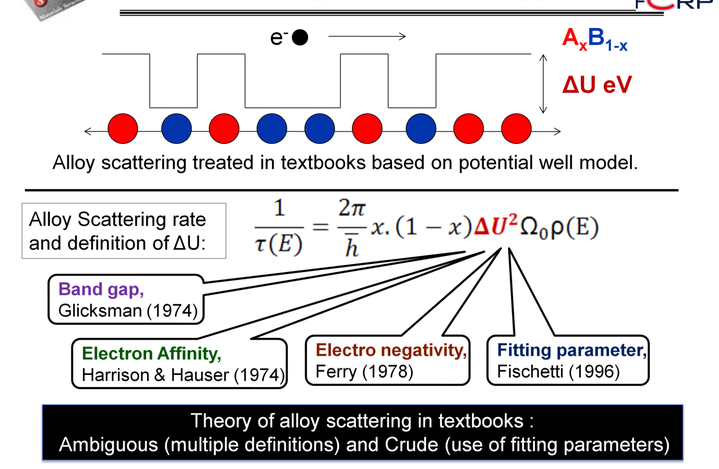
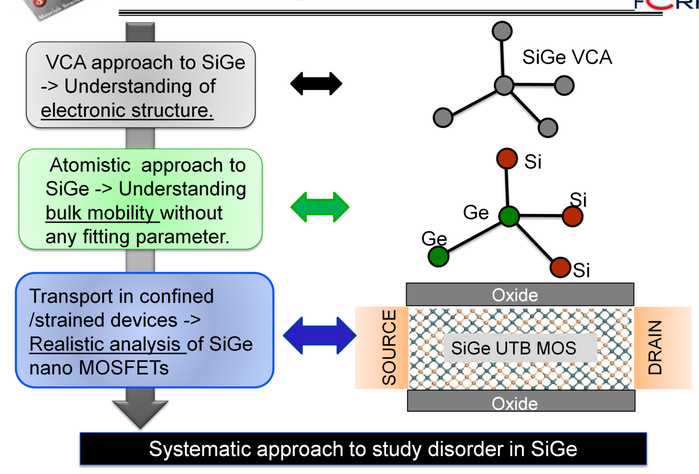
Device Scaling to 10 nm regime



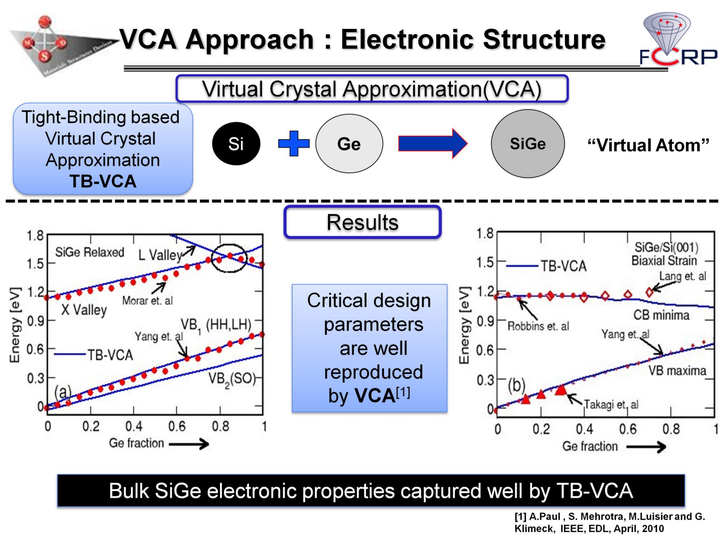
Disorder in alloys : Textbook approach



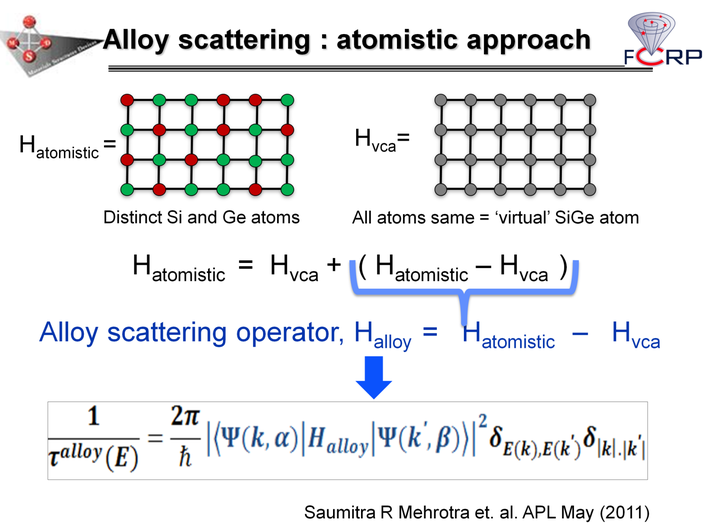
Understanding role of disorder in SiGe



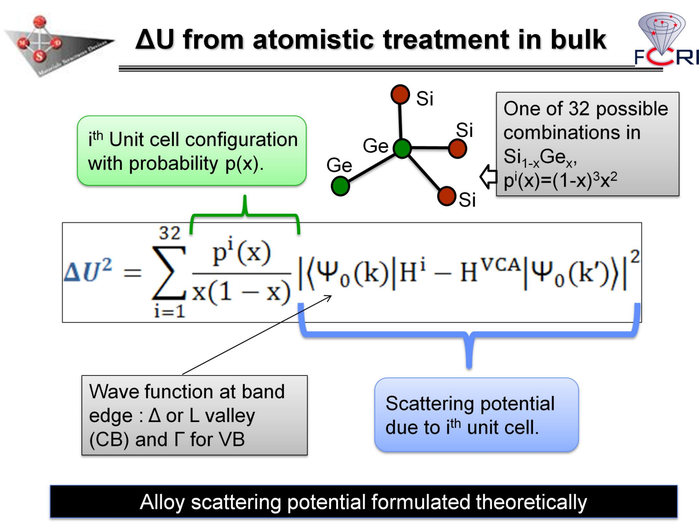
VCA Approach : Electronic Structure



Alloy scattering : atomistic approach

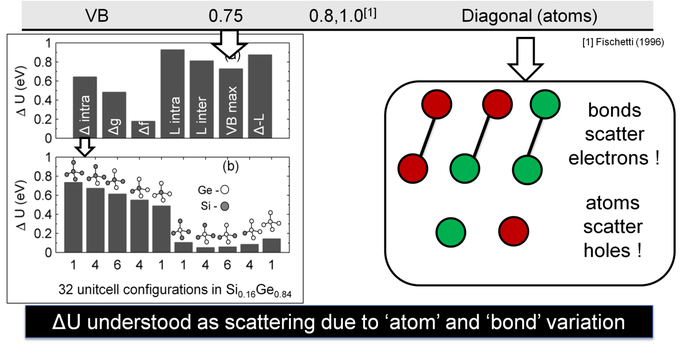


ΔU from atomistic treatment in bulk



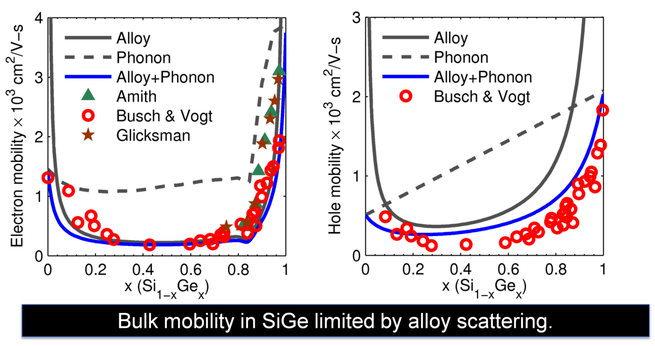
Break down of ΔU

Band edge $Si_{1-x}Ge_x$	ΔU_{TB} (eV)	ΔU_{expt} (eV)	Main Contributing block
CB (x<0.84)	0.90	0.7[1]	Both (atoms and bonds)
CB (x>0.84)	1.67	1.0[1],0.6[1]	Off-Diagonal (bonds)
VB	0.75	0.8,1.0[1]	Diagonal (atoms)



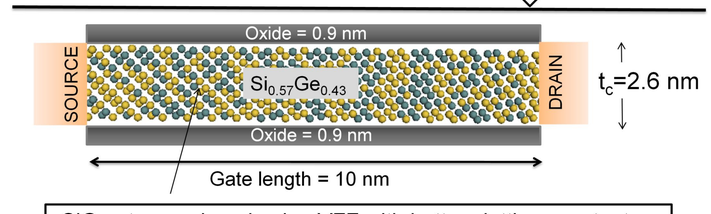
Bulk mobility : Role of alloy disorder

- Bulk mobility in SiGe calculated using Boltzmann equation.
- Phonon mobility (Fischetti 1996) and Alloy mobility (this work).



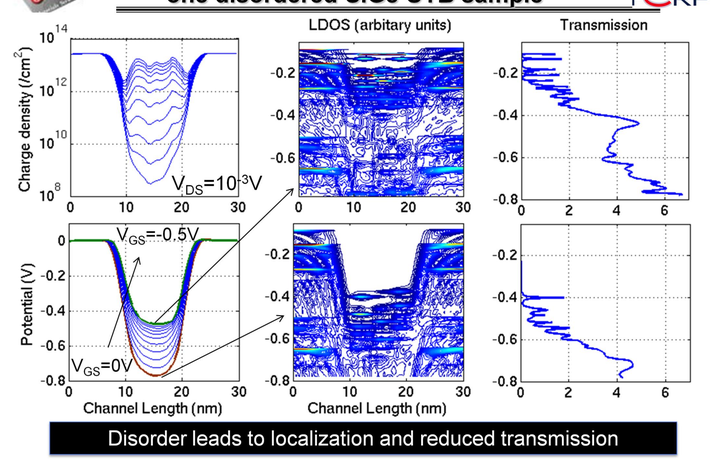
Moving towards nano MOSFETs

Understood disorder in bulk, now apply in SiGe MOSFETs.

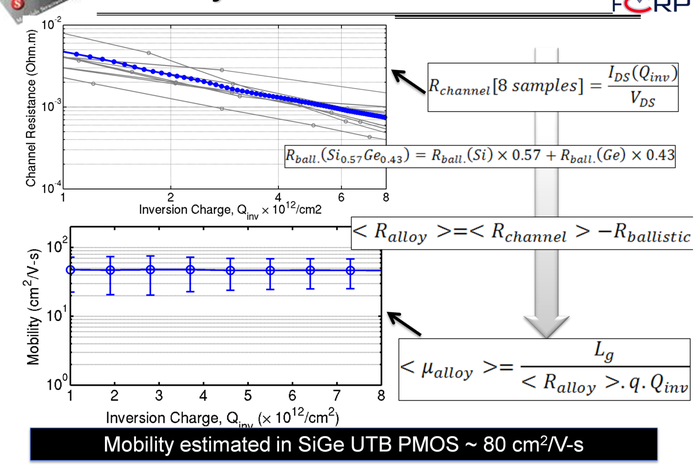


- SiGe atoms relaxed using VFF with bottom lattice constant fixed to Si lattice constant i.e. biaxial strained SiGe channel.
- 8 samples used in the study with 43% Ge.
- Low V_{DS} =-1meV used to estimate mobility

Charge and Potential Profile in one disordered SiGe UTB sample



Mobility calculation in SiGe UTB



Summary and Future Work

- Alloy scattering potential *ΔU* (only a fitting parameter in textbooks) calculated theoretically for bulk SiGe using tight-binding model.
- ΔU shown to be influenced by both '*atoms*' and '*bonds*' as opposed to the conventional 'potential well' model.
- Atomistic approach provides a holistic understanding and approach to study alloy limited SiGe mobility in nano MOSFETs.

FUTURE WORK

- Transport simulation of Ultra Thin Body and Nanowire SiGe devices using OMEN and NEMO5.
- Understand role of disorder with strain and different orientations.

MSD Annual Review May 10-11, 2011