Active Layer Parametrics, Inc.

QUANTITATIVE STRAIN and DEFECT ANALYSIS

ALP Inc. DHE Capabilities and Advantages:

- Direct measurement of μ and ρ profiles along with n profiles
- Measurement Resolution ~ 5 Angstroms
- Room Temperature Process – No Thermal Steps required
- Clean Procedure – Compatible with Production Sequence
- Fully Automated Measurement Operation – Repeatability

Defect Measure:

- Measure of deviation of the measure (DHE Drift Mobility) from the ideal (ASTM derived mobility). Presence of lattice damage.

Matthiessen's Rule: (=0, for Ideal)

$$\frac{1}{\mu} = \frac{1}{\mu_{impurities}} + \frac{1}{\mu_{lattice}} + \frac{1}{\mu_{defects}} \ldots$$

- Subtracting the ideal (ASTM, defect-free, strain-free),

$$\frac{1}{\mu_{Measured}} - \frac{1}{\mu_{Ideal}} = \frac{1}{\mu_{defects}} - \frac{1}{\mu_{strain}}$$

Defect and Strain Analysis:

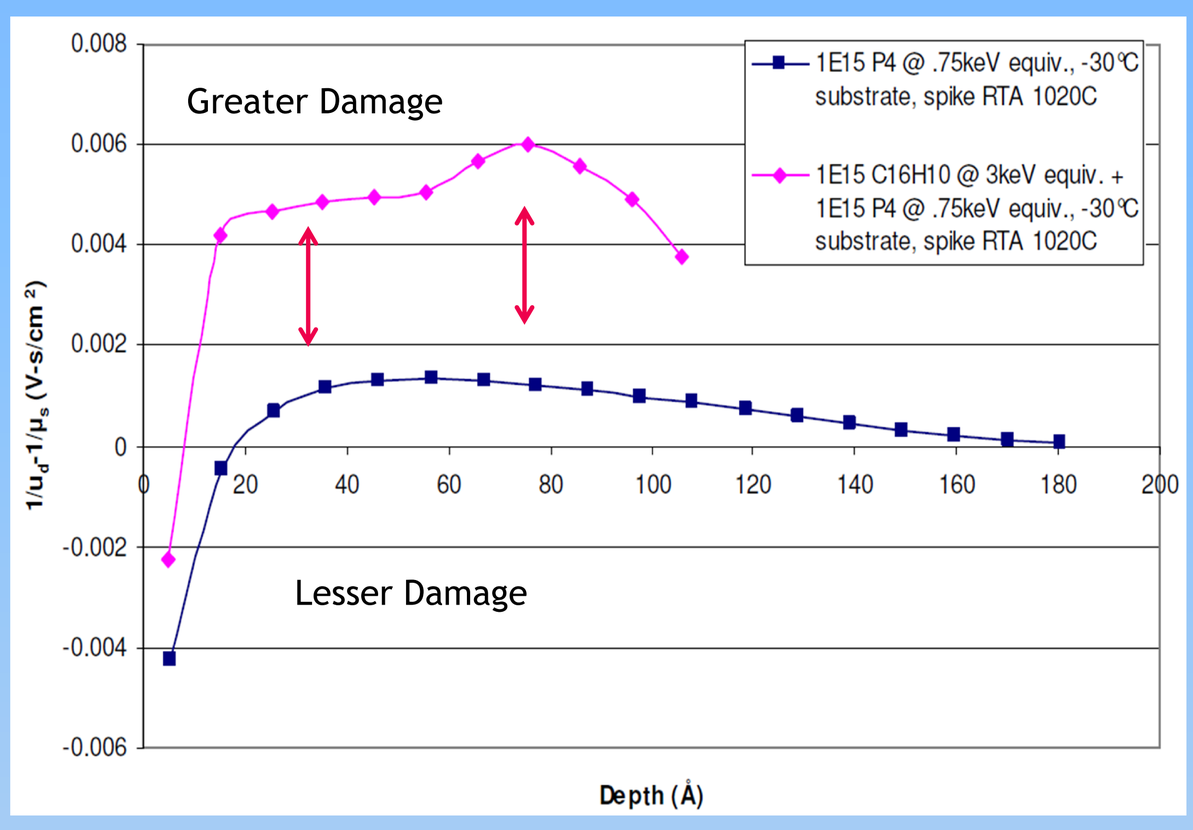
- The sign and value of the defect measure allows us to *quantify* mobility enhancement or degradation

$$\frac{1}{\mu_{Measured}} - \frac{1}{\mu_{Ideal}} = 0 \Rightarrow \text{IDEAL}$$

$$\frac{1}{\mu_{Measured}} - \frac{1}{\mu_{Ideal}} > 0 \Rightarrow \text{MOBILITY DEGRADED - DEFECT DOMINATED}$$

$$\frac{1}{\mu_{Measured}} - \frac{1}{\mu_{Ideal}} < 0 \Rightarrow \text{MOBILITY ENHANCED}$$

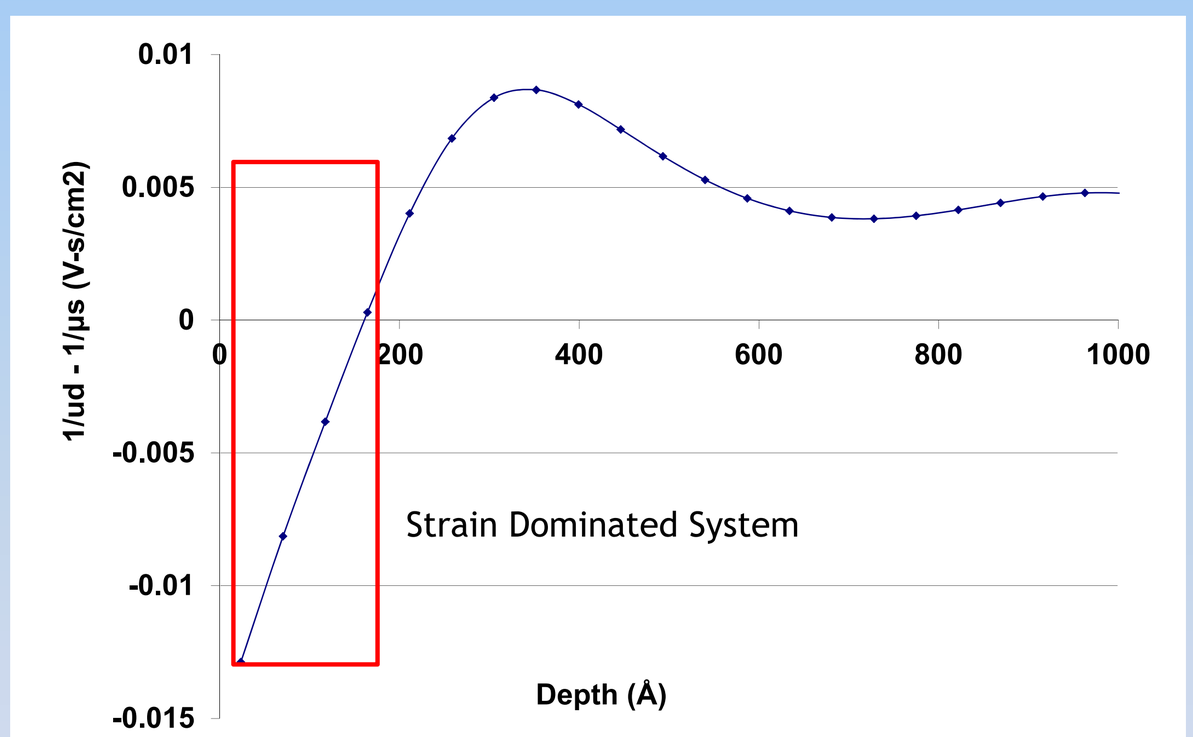
Pre-Implants and Defects:



Strain-Dominated Systems: SiGe

- Combined very-high dose Ge+B plasma implantation + high-powered laser anneal
- Structural Data by XRD and XTEM : 20% Ge and 55% Ge
- DHE showed 70% increase in mobility for 20% and 4.3x increase for 55%
- 55% concentration peak at ~20 A

[IWJT 2013, Borland, et. al.]



Plasma Doping Vs. BeamLine Doping [w/ Micron Tech]

"Scatter Defects strongly correlate to the implant ion specie atomic mass unit and energy"

Implant Type	Energy/ Dose [eV/cm^2]	RTP/spike	DHE Surface Defect $1/\mu_{DEF}$
BL B	500/1E15	1000°C	0.013
PLAD B2H6	1.2k/5E15	1000°C	0.000
BL B18H22	10k/5.56E13	1000°C	0.050
PLAD BF3	1.7k/4E15	1000°C	0.000

IEEE Trans. Plas Sci. March 2012, Qin, McTeer, *etal.*

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