New Dimensions in Metrology

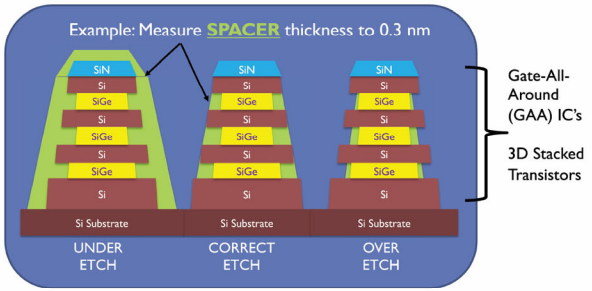
NL-OCD: A New Measurement Technology for GAA IC's

David L. Adler*, Tim Wong and Jianing Shi, FemtoMetrix, Los Angeles, USA
Michael Nielsen, Univ. New South Wales, Sydney, Australia
Aelan Mosden and Yun Han, TEL Technology Center, USA
Gustavo Grinblat and Gianni Moretti, Univ. Buenos Aires, Argentina
*Dave.Adler@Femtometrix.com

- **NL-OCD** is a natural extension of OCD for higher sensitivity at the 3nm node
- ***NL-OCD* = *Non-Linear* OCD** is a new approach to OCD metrology
- NL-OCD is based on *Second-Harmonic Generation* (SHG)
- NL-OCD has very high sensitivity to nanometer changes in geometry
- NL-OCD is suitable for high-throughput, inline metrology

Example: Thickness of Inner Spacer Etch

- There is currently no inline metrology tool for Inner Spacer etch.
- This is a "Must Have" metrology: no etch stop for this process step!



Inline Metrology Requirements for GAA

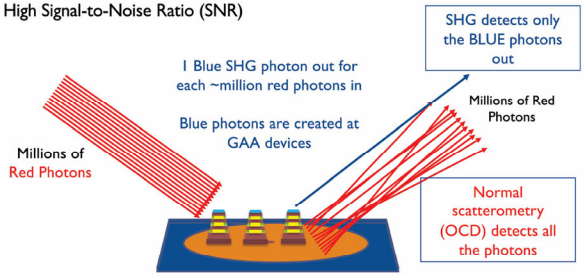
- Needs:
- Measure 3D Geometry of GAA devices to ≤ 0.3 nm
- Multiple Parameters
- Insensitive to prior-layer changes
- Non-Destructive
- High-Throughput (60 WPH)

- Wants:
- Works on actual product: No test structures
- Works on multiple process steps
- Compact footprint
- Cost-effective, reliable technology

- Meeting these needs requires a new technology

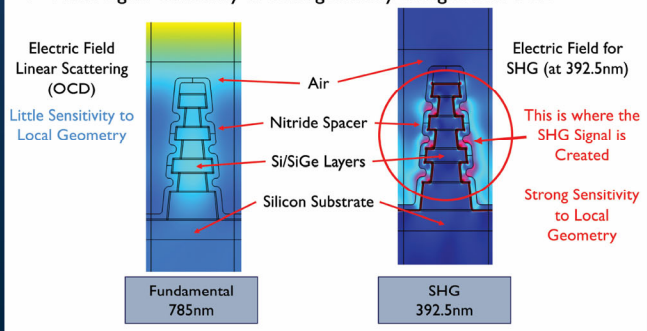
New Tech: NL-OCD (Non-Linear OCD)

- NL-OCD uses Non-Linear Optics: *Second Harmonic Generation (SHG)*
- SHG is extremely sensitive to nanometer changes in geometry
- Signal comes mostly from features of interest, less sensitive to prior layers
- High Signal-to-Noise Ratio (SNR)



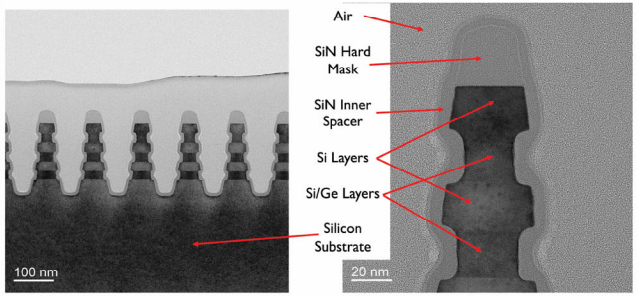
Why Use SHG for GAA Metrology?

- SHG is created primarily by devices to be measured = High SNR
- Much higher sensitivity to small geometry changes than OCD



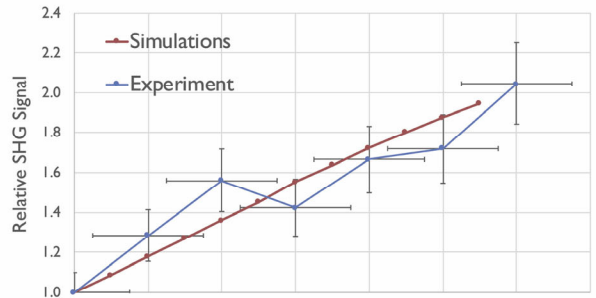
Gate-All-Around Test Structures

- SiN Inner Spacer thickness = 0 to 11.5 nm after etch (nominal)
- Supplied by TEL R&D America



Nanometer Sensitivity to Nitride Etch

SHG Signal Sensitivity ~10% / nanometer
Precision goal is 0.3 nm 3σ



Potential Advantages of NL-OCD

Feature	NL-OCD	Normal OCD
Signal Sensitivity per nm	10% per nm	<1% per nm
Background Signal	Small	Large
Prior Layer Sensitivity	Low	High
Sensitivity vs Feature Size	More sensitive as features get smaller	Less sensitive as features get smaller
3D Sensitivity	Good	Poor
Can be used on actual product?	Test structures likely not required	Requires test structures
Non-destructive?	Yes	Yes