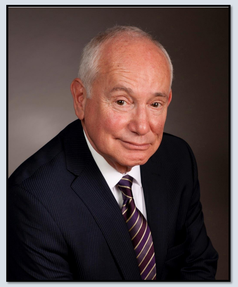
The Electronic Materials Research Group at MIT

Discover - Understand - Apply - Prototype

Anu AGARWAL
Principal Research Scientist
MIT Microphotonics Center

Jürgen MICHEL
Senior Research Scientist
MIT Microphotonics Center



Lionel C. KIMERLING
Thomas Lord Professor of Materials Science and Engineering
Director, MIT Microphotonics Center

Xiaoman DUAN
Research Scientist
MIT Microphotonics Center

Cory JAMES
Administrative Assistant
to Prof. Lionel C. Kimerling

Rui-Tao Wen
Ruitaow@mit.edu
13-4130

Integrated Micro-optical Concentrator Photovoltaics with Lateral Multijunction Cells

Achieve high quality Ge on Si wafers for photovoltaics applications

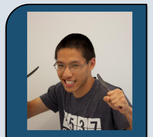
Xueying Zhao
xueying@mit.edu
13-4138

Danhao Ma
madanhao@mit.edu
13-4138

Ge and GeSi Microphotonics Platform

Material design and device fabrication for integrated photonics including photon detectors and modulators

Eveline Postelnicu
eviolin@mit.edu
13-4138

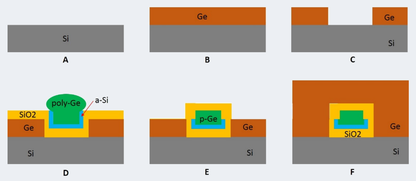


Peter Su
peterxsu@mit.edu
13-4138

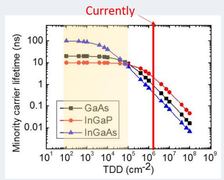
Integrated Mid-Infrared Sensing Platform

Material and device design to integrate a mid-IR light source, sensing element, and detector on a Si CMOS chip

- Performance of III-V solar cells is strongly related to the quality of Ge-on-Si substrates. The threading dislocation in Ge layers will be minimized from the optimization of Ge epitaxial growth.
- The same thermal expansion coefficient between Ge and poly-Ge allow threading dislocations move and penetrate during cycling annealing.
- A second epitaxy growth (based on the structure of step E) will yield Ge thin film with very low TDDs.



General approach to achieve very low TDD of Ge on Si wafers



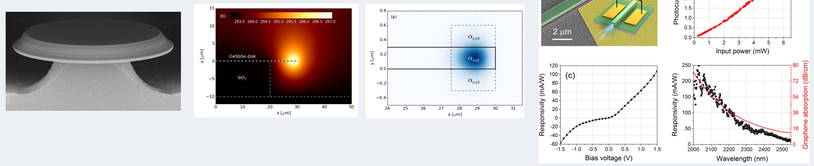
Minority carrier lifetimes dependence on TDDs for III-V solar cells

Derek Kita
dkita@mit.edu
13-4153

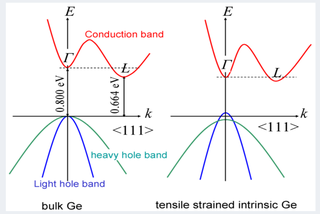
High-performance Mid-Infrared Photonic Devices for Sensing

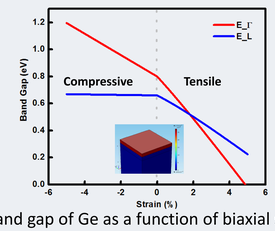
Design, simulation, fabrication, and testing of unique photonic materials and device architectures for high-performance spectroscopy in the mid-infrared

- Suspended chalcogenide microdisk structures for ultra-sensitive photothermal spectroscopy
- Mid-infrared modulators and detectors utilizing PbTe and 2D materials integrated with chalcogenide glass photonics



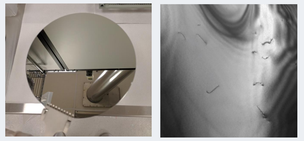
- Grow epitaxial Ge with small amounts of Si
- Electro-absorption modulator fabrication process development
- Realize a scalable integrated quantum photonic interconnect





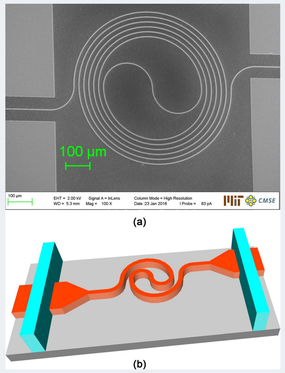
Band gap of Ge as a function of biaxial strain

Schematic of UHV CVD Ge film growth
* Dimensions of the layers are not corresponded.

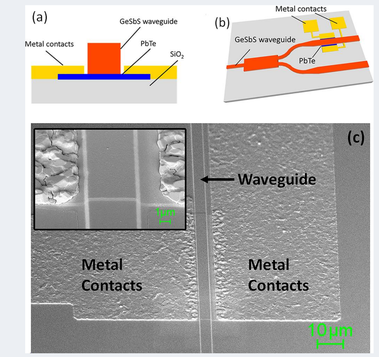


Specular Ge film surface and TEM image of threading dislocations in Ge on Si system

- On-chip polycrystalline PbTe photoconductive detector integrated with a chalcogenide glass waveguide
- On-chip sensor for room-temperature detection of methane gas using a broadband spiral chalcogenide glass waveguide coupled with off-chip laser and detector



On-chip sensor for room-temperature detection of methane: (a) single-mode spiral waveguide. (b) schematic representation of the waveguide design



Chalcogenide glass waveguide integrated PbTe photoconductive detector: (a) schematic cross-sectional view of the integrated MIR detector (not to scale). (b) representation of the chip design. (c) A 45 view SEM image of the device.

Selected Recent Publications

Z. Han, V. Singh, D. Kita, C. Monmeyran, P. Becla, P. Su, J. Li, X. Huang, L. C. Kimerling, J. Hu, K. Richardson, D. T. H. Tan, and A. Agarwal, *Applied Physics Letters* **109,** 071111 (2016)
Z. Han, P. Lin, V. Singh, L. Kimerling, J. Hu, K. Richardson, A. Agarwal, and D. T. H. Tan, *Applied Physics Letters* **108**, 141106 (2016)
N. S. Patel, C. Monmeyran, A. Agarwal, and L. C. Kimerling, *Journal of Applied Physics* **118**, 155702 (2015).
C. Bao, L. Zhang, L. C. Kimerling, J. Michel, and C. Yan, *Optics Express* **23**, 18665 (2015).
P. T. Lin, J. Giammarco, N. Borodinov, M. Savchak, V. Singh, L. C. Kimerling, D. T. H. Tan, K. A. Richardson, I. Luzinov, and A. Agarwal, *ACS Appl. Mater. Interfaces* **7**, 11189 (2015).
C. Bao, C. Yang, L. Zhang, L. Kimerling, and J. Michel, in CLEO: 2015, OSA Technical Digest (Optical Society of America, 2015), paper JTu5A.40.
D. T. H. Tan, A. M. Agarwal, and L. C. Kimerling, *Laser & Photonics Reviews* **9**, 294 (2015).
Z. H. Han, L. Zhang, L. C. Kimerling, and A. M. Agarwal, *IEEE Journal of Selected Topics in Quantum Electronics* **21**, 1603007 (2015).
L. Z. Broderick, B. R. Albert, B. S. Pearson, L. C. Kimerling, and J. Michel, *Solar Energy Materials & Solar Cells* **136**, 48 (2015).