quantum semiconductor

Quantum Semiconductor LLC

EXECUTIVE TEAM

CEO & Co-Founder:
Lynn Forester, Ph.D., MBA

CTO & Co-Founder:
Carlos Augusto, Ph.D.

VP of Engineering:
Pedro Diniz, Ph.D.

COMPANY HISTORY

Field of activity: LIDAR, Si-Photonics, CMOS Image Sensors, CMOS APDs, Advanced CMOS

Business Model: Fabless semiconductor company

R&D CONTRACTS

DARPA 2016 SBIR Phase 1: Near Single Photon Counting APD Arrays.

ONR 2015 SBIR Phase II: APDs with SiGeC Materials.

NSF 2013 SBIR Phase 1: Theoretical and experimental study of Si-Ge-C superlattices.

DARPA 2008 Seedling: Fabrication of 2D CMOS pixel arrays with SiGeC Avalanche Photo-Diodes (APDs).

COLLABORATIONS

INESC-MN, Lisbon, Portugal: Development of software for ab-initio simulations of superlattices

SILVACO, Santa Clara, USA: TCAD simulation of superlattice materials and devices

COMPANY CONTACT

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Imaging and LiDAR Arrays for Visible and Infra-red

Quantum Semiconductor is developing imaging arrays for solid-state LIDAR to increase performance and reliability, *and* reduce size, power consumption, and cost.

Our vision - Combine the advantages of CMOS with materials having superior optoelectronic properties. The result - Enabling a silicon-based technology to compete in products and markets that currently can only be served by III-V compound semiconductors.

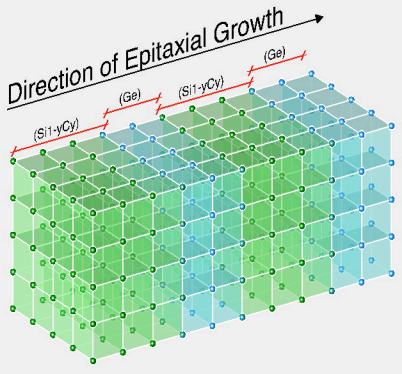
The image sensor for Visible + NIR, is a CMOS array capable of single-photon counting at low voltage and room temperature, with high dynamic range, suitable for passive imaging and LIDAR.

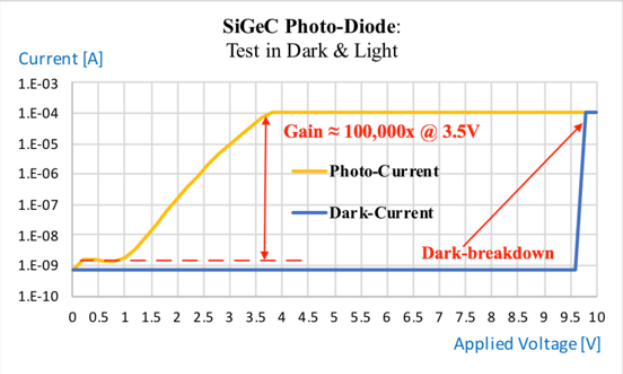
SWIR sensors will incorporate new photo-absorption materials into photo-diodes, with large internal gain, to make large CMOS Image Sensor arrays for near-photon counting, with high dynamic range sensing.

Feature	Advantage	Benefit
Single photon detection & counting capability	More sensitive than existing CMOS Image Sensors (CIS)	Earlier threat detection- See farther, sooner….
Near IR and Visible Imaging	Improvement over CIS which have very low sensitivity in the NIR	Better image resolution and more information from surroundings
Low Light Level Imaging in Visible Wavelengths	Improvement over CIS because of improved responsivity	Faster frame rate, better imaging capability
Monolithic integration with CMOS	Smaller pixels, higher resolution, pixel designs for high dynamic range	Cameras that are smaller, lighter, less power hungry, more reliable
Commercial CMOS-based technology	High yield, lower cost of manufacturing based on economies of scale	Large scale production and consumer-level applications

New Materials + New Devices = Better Performance

Photo-absorption by new Silicon-based materials allows imaging in the infra-red. New device designs allow noiseless high gain at CMOS voltages. The *result* - Performance superior to state-of-the-art APDs, large arrays with the cost and reliability of CMOS, and no need for ROICs.





Quantum Semiconductor is leads the development of CMOS-based photo-diodes with large internal gain. Quantum Semiconductor is familiar with Trusted Foundry US manufacturing protocol and has manufactured test chips on-shore at both TowerJazz and IBM (GF).

Investment Opportunities to Accelerate Development

We are seeking both private sector and DOD customers, investors and strategic alliances to further our material and product development.

Quantum Semiconductor technology brings size, weight, cost and performance advantages to DOD requirements for Visible+NIR imaging, SWIR imaging and LiDAR.

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COMPANY HISTORY

Founded in 2001

Field of activity: LIDAR, Si-Photonics, CMOS Image Sensors, CMOS APDs, Advanced CMOS

Business Model: Fabless semiconductor company

RESEARCH CONTRACTS

DARPA 2016 SBIR Phase 1: Near Single Photon Counting APD Arrays. Completed.

ONR 2015 SBIR Phase II: APDs with SiGeC Materials. Completes 6/2019.

NSF 2013 SBIR Phase 1: Theoretical and experimental study of Si-Ge-C superlattices. Completed.

DARPA 2008 Seedling: Fabrication of 2D CMOS pixel arrays with SiGeC Avalanche Photo-Diodes (APDs). Completed.

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Company Snapshot

Quantum Semiconductor is focused on developing components for solid-state LIDAR that will increase performance and reliability, reduce size, power consumption, and cost. These improvements will be achieved through a new, patented, light-sensing technology, suitable for single-photon detection, in large 2D arrays of pixels (> 1 MegaPixel). It can also be used for ultra-sensitive passive imaging.

The technology is CMOS-based, which is the key to high-yield, high-uniformity, reliability and low cost of manufacturing. It combines two main innovations, both patent-protected:

1) SiGeC photo-diode, integrated with CMOS, which exhibits large internal gain (> 100K) at low voltage (<3.5V). The gain is noiseless and the mechanism is not conventional avalanche.
2) Si-Ge-C Superlattices, integrated with CMOS, as the light-sensing region of photo-diodes, having optoelectronic properties comparable to those of III/V materials, such as InGaAs. Multiple Si-Ge-C Superlattices can cover multiple spectral regions, from UV to LWIR.

The vision is to combine the advantages of CMOS manufacturing with materials having superior optoelectronic properties, thereby enabling a silicon-based technology to compete in products and markets that currently can only be served by III-V compound semiconductors.

Beyond LIDAR, these include passive imaging, wide-spectrum photovoltaic cells, telecommunications, optical interconnects and Si Photonics.

Capabilities Overview

The Quantum Semiconductor founding team brings together strong backgrounds in device physics, chemistry, surface science, engineering, manufacturing, and computer science. We are driven by scientific integrity, attention to detail, and visionary innovation to develop game-changing technology.

Advanced CMOS Device and Circuitry Design: Quantum Semiconductor has expertise in the design of a wide variety of semiconductor devices, including MOSFETs, HBTs, Photo-Diodes with internal gain, design of sensor circuitry for pixels, periphery and novel ADCs, and fabrication flows.

Research and Development of Atomistic Simulation Codes: Quantum Semiconductor has collaborated in the development of codes to perform atomistic simulations of group-IV materials, to discover compositions with good optoelectronic properties, as well as TCAD simulations of devices incorporating new materials.

Development of Optimized Monte Carlo Codes: Quantum Semiconductor is developing a 3D, full band structure, Monte-Carlo simulator incorporating an extensive range of physical models to simulate the new noiseless gain mechanisms observed in the SiGeC photo-diodes.

Manufacturing: Quantum Semiconductor is leading the development of internal high gain photo-diodes. Quantum Semiconductor is familiar with Trusted Foundry US manufacturing protocol and has designed and manufactured test chips on-shore at both TowerJazz and IBM (GF).

Intellectual Property

Quantum Semi has a strong IP portfolio consisting of 20 issued U.S. patents, many foreign patents issued in the EU, China and Japan, and multiple additional patents pending. Patents cover photodiode design, superlattice materials and applications, analog-to-digital converters for sensors, CMOS transistor concepts, sensor circuitry, pixel designs and modes of operation, and camera design.

Product Development Roadmap

Product development is ongoing through chip design and manufacture at a US-based BiCMOS foundry. The Gen 1 prototype sensor is a 128x128 CMOS sensor array with near single photon counting, high dynamic range, suitable for passive imaging and LIDAR, operating in Visible and NIR, with large internal gain (> 100K) at low voltages (<3.5V).

The development of Group-IV superlattice films capable of covering SWIR to 1.6µm with a coefficient of absorption comparable to that of InGaAs, is currently underway.

Gen 2 sensors will incorporate Group IV superlattices into photo-diodes with large internal gain, to make large 1 MegaPixel CMOS Image Sensor arrays for near-photon counting, high dynamic range in SWIR.