Joint CQSE & NCTS Seminar

2021
Nov. 12, Friday

TIME Nov. 12, 2021, 2:30~3:30pm
TITLE The Wonderful World of Designer Germanium Quantum Dots for CMOS Integrable Quantum Devices
SPEAKER Prof. Pei-Wen Li
Dept. of Electronic Engineering, National Yang Ming Chiao Tung University
PLACE Rm104, Chin-Pao Yang Lecture Hall,
CCMS & New Physics Building, NTU

Abstract:

Cutting-edge research on Si-based quantum dots (QDs) has opened up access to wide-ranging applications in electronics, photonics, quantum computing, and sensing. The "holy grail" for device manufacturers is to achieve scalability through precise control and repeatable fabrication of QDs with desired shapes, sizes, and ac-curate placement for predictable electrical and optical proper-ties. A Bohr radius of 5 nm in Si dictates the fabrication of ultrasmall Si QDs, which are difficult to controllably produce using either self-assembly or lithographic techniques. In contrast, a large Bohr radius of 25nm in Ge enables easier modification of electronic structures using Ge QDs, imposing less stringent demands on lithographic control.

Starting with our remarkable discovery of spherical germanium (Ge) QD formation, we have embarked on an exciting journey of further discovery, all the while maintaining CMOS-compatible processes. We have taken advantage of the many peculiar and symbiotic interactions of Si, Ge and O interstitials to create a novel portfolio of electronic, photonic and quantum computing devices. This paper summarizes several of these completely new and counter-intuitive accomplishments. Using a coordinated combination of lithographic patterning and self-assembly, size-tunable spherical Ge QDs were controllably placed at designated spatial locations within Si-containing layers. We exploited the exquisite control available through the thermal oxidation of Si1-xGex patterned structures in proximity to Si3N4/Si layers. Our so-called "designer" Ge QDs have succeeded in opening up myriad device possibilities, including paired QDs for qubits, single-hole transistors (SHTs) for charge sensing, photodetectors and light-emitters for Si photonics, and junctionless (JL) FETs using standard Si processing.

Biography Brief:

PEI-WEN LI received her Ph.D. degree from Columbia University in New York city, in Electrical Engineering in 1994.

She is a Professor in Institute of Electronics and served as the Director of Nano Facility Center at National Chiao Tung University (NCTU) in Hsinchu. Prior to joining NCTU in 2015, she has been the Distinguished Professor (2006-2015), the Chair of Electrical Engineering Department (2007-2010), Director of Nano Science and Technology (2012-2015), and Associate Dean of Academic Affair (2013-2015) in National Central University. She was a Research Visiting Scholar with Caltech in 2011-2012. She has also worked with Vanguard International Semiconductor Corporation on DRAM technology integration in 1995-1996. Her research themes focus on experimental silicon-germanium nanostructures and devices,

encompassing germanium quantum-dot single electron transistors, photodetectors, nonvolatile memory, and energy saving/harvest (photovoltaic and thermoelectric) devices, making use of self-assembly nanostructures in silicon integration technology.

She is an IEEE Distinguished Lecturer and serves VLSI Technology and Education committees of IEEE EDS. She has served on various important conference committees, e.g., IEEE SNW, IEEE EDTM, SSDM etc. She is also the Editor Board Member of Applied Physics A-Materials Science & Processing, Springer. She was awarded Distinguished Professor from Chinese Electrical Engineering Society (2015) and Top 10 Rising Stars in Taiwan (Science and Technology) from Central News Agency in 2008.