Quantum Technologies based on Si/SiGe and SiCOI

T. D. Ladd
HRL Laboratories, LLC, Malibu, CA 90265, USA
tdladd@hrl.com

Semiconductor quantum technologies have undergone significant progress in the past few years, due recently to innovations in device designs, and historically due to the promise of leveraging the considerable fabrication resources of the semiconductor microelectronics industry [1]. This talk will address progress in spin qubits based on silicon, presently under development at a growing number of academic, government, and commercial organizations, with particular focus on the Si/SiGe exchange-only qubit under development at HRL Laboratories. HRL has now performed encoded universal logic in an array of 6 single electron spins in 6 quantum dots (Fig. 1, left) controlled only with DC voltages, an approach with high promise for future scalability [2]. I will also address semiconductor approaches to the problem of moving quantum information with light, with applications in sensing, quantum communication, and modularization of quantum computers. I will focus on an emerging approach to nonlinear quantum integrated photonics using SiC on insulator (SiCOI, Fig. 1, right). The growing interest in this material [3] is due to its strong potential for providing a platform for quantum optical sources, routing, and memory, in conjunction with the continued advancement of the industrial infrastructure for its production, and I will show how recent fabrication advances exhibit considerable promise for scaling these quantum technologies into a realm of genuinely advantageous utility.

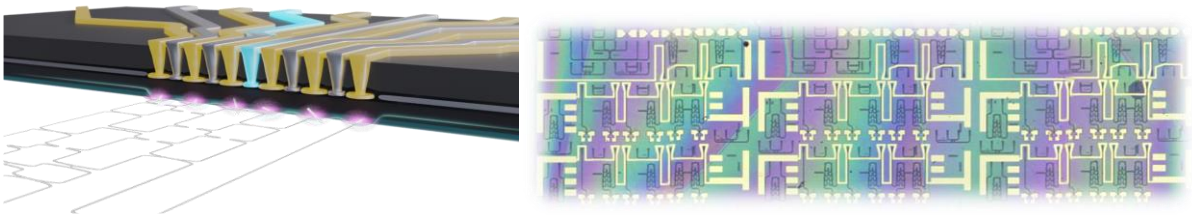

Fig.1. Characteristic images of technologies discussed. Left: artist's rendering of six Si/SiGe quantum dots undergoing exchange-only quantum logic. Right: microscope image of photonic integrated circuit using SiCOI.

References

[1] Burkard et al., Reviews of Modern Physics **95**, 025003 (2023)
[2] Weinstein et al., Nature **615**, 817 (2023)
[3] Anderson and Awschalom, Physics Today **76**, 26 (2023)