UC SANTA BARBARA

THE Current

February 25, 2026
UCSB Engineering

A robust new telecom qubit in silicon

Quantum technologies are anticipated to transform computing, communication and sensing by harnessing the unusual behavior of matter at the atomic scale. Translating quantum's promise into practical devices will require physical systems that have desirable quantum properties and can be easily manufactured. Silicon, the material behind today's computer chips, is highly attractive as a platform because it plays to the strengths of the trillion-dollar semiconductor industry that has already been built. Identifying quantum building blocks — qubits —in silicon is, therefore, an important frontier research area.

In a new study, researchers in UC Santa Barbara materials professor Chris Van de Walle's Computational Materials Group identified a robust new qubit in silicon, called the CN center. The work is published in the journal Physical Review B.

Qubits can be based on atomic-scale defects in a crystal. A prototype example is the NV center, which consists of a nitrogen (N) atom sitting next to a vacancy (V, a missing carbon atom) in a diamond crystal. These defects can interact with both electrons and light, allowing them to emit single photons (quanta of light) that can transmit quantum information or be processed in quantum networks.

Recent work has focused on a silicon defect, the T center, which can store quantum information for long periods of time comparable to those of an NV center. It also emits light in the telecom band — the range of wavelengths that can be transmitted with low loss through optical fibers. The T center is made up of carbon and hydrogen atoms, and the presence of hydrogen renders it fragile and sensitive to fabrication conditions. Hydrogen can easily move within the crystal and is difficult to control during processing, making reproducible and reliable device manufacturing more challenging to achieve.

In their new study, the researchers identified a promising alternative: the CN center, which consists of carbon and nitrogen atoms. “Unlike the T center, this defect does not contain hydrogen and will, therefore, be more robust and easier to realize in actual devices,” said Kevin Nangoi, a postdoctoral scholar in the Van de Walle group who led the project.

The team used advanced first-principles computer simulations to model the defect at the atomic level. Because such simulations allow researchers to predict material properties of new systems that have not yet been realized experimentally, they can guide future efforts in engineering and fabricating novel devices.

“Our results show that the CN center reproduces the key electronic and optical properties that render the T center attractive for quantum applications; in particular, the center is structurally stable and produces light in the telecom range,” said Mark Turiansky, a group alumnus and now a postdoctoral researcher at the U.S. Naval Research Laboratory, who was involved in the project.

Identifying a hydrogen-free, telecom-wavelength quantum-light emitter in silicon is an important step that helps to bridge the gap between quantum science and scalable technology.

Looking ahead, Van de Walle noted, “If confirmed experimentally, the CN center could serve as a practical new building block for quantum devices, potentially accelerating the development of advanced quantum technologies [while] using the same silicon material that powers today’s electronics.”

Funding for this research was provided by the Department of Energy Office of Science, Office of Basic Energy Sciences, through the Co-design Center for Quantum Advantage (C^2QA); the computations were performed at the National Energy Research Scientific Computing Center.

Tags
Quantum Science

Media Contact
Shelly Leachman
Editorial Director
(805) 893-2191
sleachman@ucsb.edu

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.