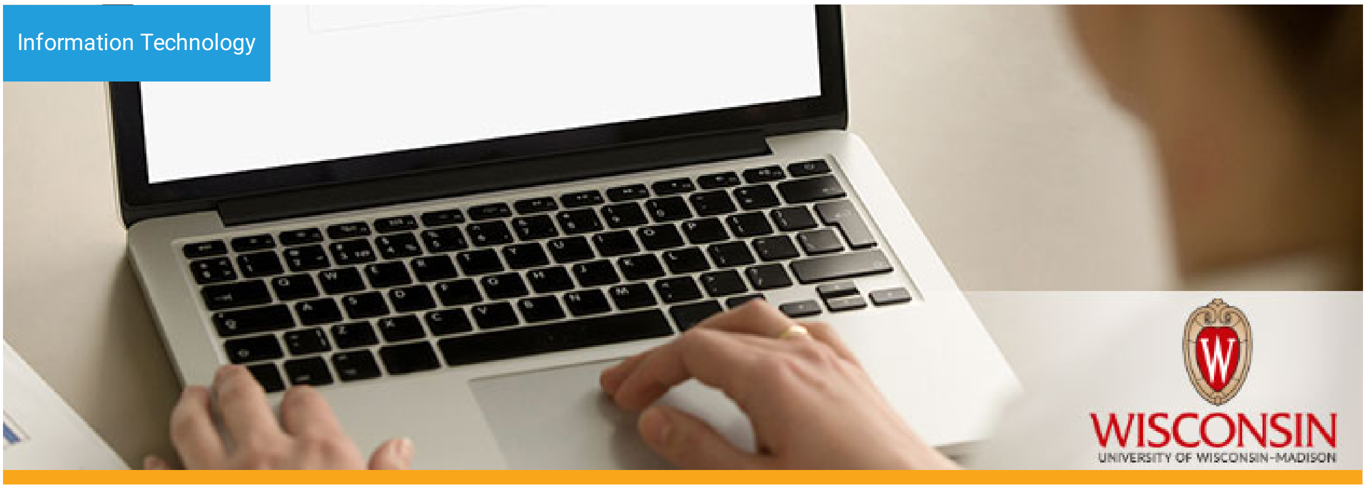

Improved Gate Design for Quantum Computers

View U.S. Patent No. 9,842,921 in PDF format.

WARF: P130184US02

Inventors: Mark Eriksson, John Gamble, Daniel Ward, Susan Coppersmith, Mark Friesen

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a semiconductor quantum dot device with better control over energy levels.

Overview

Some extremely complex tasks – like sorting very large databases or factoring large numbers – are challenging for classical computers. Quantum computers can solve such problems because they use quantum particles (e.g., electrons) called qubits to process information, instead of traditional bits. Qubits have more values than simply zero or one, allowing the computers to check multiple answers in parallel.

One of the most promising advances in solid-state quantum computing is the quantum dot. Dots can be fabricated by growing layers of semiconductors and patterning electrostatic gates on the surface (see WARF reference P01092US). By applying voltage to these gates, the flow of electrons through the dots can be controlled and precise measurements of electron spin and other properties can be made.

In essence, the gate design helps trap and manipulate electrons in quantum dots. However, existing designs don't allow for independent tuning of dot energies and gate tunnel rates, resulting in less precision and control. Moreover, the placement of gates on the surface depletes the electrons in the two-dimensional electron gas (2DEG) present underneath. Also, only negative voltage can be applied or gate leakage becomes a problem.

The Invention

UW–Madison researchers have developed quantum dots with a novel tunnel barrier gate design. The structure consists of a quantum well layer with three 2DEG regions separated by three tunnel barriers.

An electrode is patterned on a dielectric layer (instead of directly on the dot surface) above the first tunnel barrier. The various electrodes formed on the dielectric layer are arranged to define quantum dot regions within which the energy level and spin of electrons can be manipulated.

The multiple layers of the structure can be made using conventional deposition systems or lithography techniques.

Applications

- Semiconductor quantum dots
- Quantum computing qubits and spintronics

Key Benefits

- Facilitates independent control over tunnel barriers, total charge and position of quantum dots

- Easier to tune
- Cuts down on interference between other components
- No dopants are required.
- Scalable
- Applied voltage can be positive or negative.

Stage of Development

Simulations verify that the new design performs as expected, enabling greatly enhanced tuning of electronic tunnel barriers.

Additional Information

For More Information About the Inventors

- Susan Coppersmith
- Mark Friesen

Related Technologies

- WARF reference number P01092US describes a different design for semiconductor quantum dots.

Tech Fields

- Information Technology : Computing methods, software & machine learning
- Information Technology : Hardware

For current licensing status, please contact Emily Bauer at emily@warf.org or 608-960-9842