Utilizing InSb/Si Quantum Dots for the Development of Next-Generation Multivalued High-Mobility Transistor Technology

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Transistors themselves have not fundamentally changed in decades, with all advances in the field focused on merely decreasing the size of transistors. This is a problem as soon it will be impossible to continue to shrink transistors further. Transistors have also been exclusively focused on binary, with research into alternative logical systems extremely limited. In this research, a commercially competitive multivalued transistor is created order to improve transistors fundamentally and avoid stagnation. A Quantum Dot Field Effect Transistor (QDFET) design was utilized as Quantum Dot's (Qdots) promote tunneling through cladding layers, allowing for multiple stability regions. In order to design this QDFET, I developed a novel Monte-Carlo optimization algorithm to efficiently design molecules with many atomic possibility. The Monte-Carlo algorithm was coupled with Density Functional Theory (DFT), to simulate many of the molecules. In addition I devised a Neural Network (NN) model to approximate DFT simulations for certain large volume calculations. Through the use of the NN and Monte-Carlo algorithm, an Indium Antimonide/Silicon-based QDFET was discovered for usage as a next-generation multivalued transistor. A device was then fabricated and the Hall effect across a Qdot matrix was measured. This device was found to have electron mobility over three orders of magnitude ahead of other multivalued options and significantly higher efficiency. With electron mobility on par with mature commercial options and its incredible multivalued logic benefits, this work produces a QDFET with effective performance over ten-fold in excess of any conventional transistor, promising a revolution in chip technology and an escape from Moore's Law, with widespread effects on all of computing.

Awards Won:
First Award of $5,000
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: Full Scholarship from King Fahd University of Petroleum and Minerals(KFUPM) (and a $400 cash prize)
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: NOT TO BE READ -- $400 cash prize for each Full Scholarship from King Fahd University award recipient
Central Intelligence Agency: First Award: $1000 award