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Single-Electron Transport and Device Applications

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In recent years, there has been a considerable amount of theoretical and experimental activity involving surface acoustic waves (SAWs). Interest in this field has centered around the evidence for single -electron transport in piezoelectric materials such as GaAs/AlGaAs heterostructures and its potential use as a current standard. Several device applications involving SAWs for transporting electrons (and holes) include quantum computing, where the spin is the qubit that is moved across a network of quantum gates by SAWs, and a single-photon source through the recombination of electrons and holes. The SAW quantum computer is a dynamic qubit type where the quantum information actually travels during the computation. This type of qubit has the advantage of delivering information quickly through the circuit when decoherence times are short. We consider specific architectures that will allow quantum entaglement and electron-hole recombination. We also propose a novel scheme of photon detection which uses SAWs for transporting photo-generated electrons and holes. Potential applications of the concept include imaging arrays in the visible and infrared regions and single photon detection. A preliminary feasibility study has indicated that the acoustoelectric photon detectors/imaging arrays can feature an extremely low dark current rate. The concept has advantages over Charge Coupled Devices (CCDs) because of its simplicity, speed of operation and high sensitivity (down to the single photon level). The device uses SAWs to transport charge along wave guides. We explore the application of the detector to the improvement of security.