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Research on Ge quantum dot spin qubit devices

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Gate-defined quantum dot spin qubit arrays based on undoped Ge/SiGe quantum wells have attracted tremendous research interest due to their long coherence time and strong spin-orbital coupling. However, the fabrication of conventional overlapping-gate quantum dot devices poses a challenge for many research groups, because it requires at least four metal layers, three oxide layers, and 10-nm alignment accuracy. Therefore, developing a simpler and more reliable architecture for Ge quantum dot arrays can speed up the material and device optimization process. Here we present a new design of Ge quantum dot devices with a global accumulation gate and depletion-style fine gates. The device fabrication consists of only three metal layers, two oxide layers, and needs only micrometer alignment accuracy. We measured these devices and successfully observed Coulomb blockade and Coulomb diamond both in DC transport and RF reflectometry. In addition, we used the Coulomb peaks to characterize the charge noise and obtained a noise power spectrum density of 1.1μeV/√Hz at 1Hz, confirming the quality of the material and device. Finally, we present our progress in spin qubit control.

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