Few-electron silicon single and double quantum dots fabricated in a metal-oxide-semiconductor structure

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Confining a single electron in a quantum dot (QD) is important for realizing electron spin qubits. However, it is still challenging for silicon because of the relatively large effective mass m^* of electrons and their small tunneling rates in silicon. We successfully realize confining a single electron in a lithographically-defined silicon QD.

We fabricate silicon QD devices in a metal-oxide-semiconductor (MOS) structure on a silicon-on-insulator substrate. Figure 1(a) and (b) show scanning electron microscope (SEM) images of single QD (SQD) and double QD (DQD) devices. Charge sensors, SCS and DSC, are fabricated near SQD and DQD, respectively. By applying a top gate voltage V_{TG} to the poly-Si top gate (TG) (not shown) formed on the SiO_2 gate insulator, a two dimensional electron gas (2DEG) is induced in the SOI layer near the Si/SiO_2 interface.

Changes in number of electrons in SQD and DQD are detected by measuring abrupt changes in the current I_{SCS} and I_{DCS} which flow through SCS and DCS as shown in Fig.1 (c) and (d), respectively. In lower left region of Fig. 1(c) and (d), there are no lines of transition of electrons in the QDs, which indicates that we successfully obtain the pinch-off of both SQD and DQD devices.

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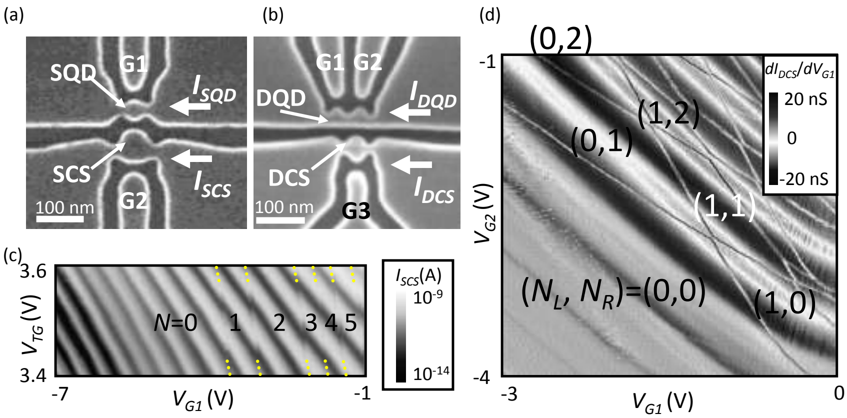

Figure 1 (a,b) SEM images of SQD and DQD devices before formation of top gate. (c) Current I_{SCS} through a charge sensor in the plane of V_{TG} and V_{G1}. The number of electron N in SQD is indicated. (d) Contour plot of dI_{DCS}/dV_{G1} as functions of V_{G1} and V_{G2}. The number of electron (N_L, N_R) in each QD of DQD is indicated.