Nanofabrication challenges and opportunities for the manufacturing of semiconductor spin qubits

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Abstract

The fabrication technology of semiconductor-based devices has experienced a sustained exponential growth for more than 6 decades. [1] Presently, the level of dimensional and material composition control is approaching the single atom accuracy, but it is still behind what it is needed for the realization of a practical computer based on semiconductor qubits. Recent progress on electrostatic gated quantum dot devices based on silicon and silicon related materials [2,3] shows that it is possible to obtain devices with very high coherence time [4]. However, at short term, the next generations of semiconductor electronic devices will require improved fabrication methods, that could fulfill accuracy requirements along with capability for scaling up in view of practical applications. Progress is needed in aspects like deterministic doping [5], lithography resolution, material compatibility for low-temperature operation, and interfacing with back-end electronics [6]. In this communication, we will review some recent advances in the field and we will present some explorative activities that are being carried out at IMB-CNM, covering from the development of novel lithography methods for the realization of single electron devices based on silicon nanowires (Figure 1, [7]) to the integration of single electron transistors with CMOS circuits (Figure 2, [8]).

References

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Figures

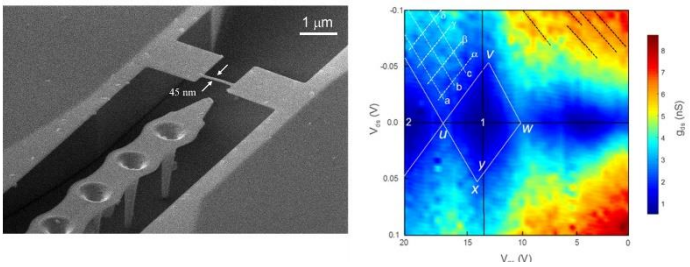

Figure 1: Suspended single hole transistor with nanocrystals embedded

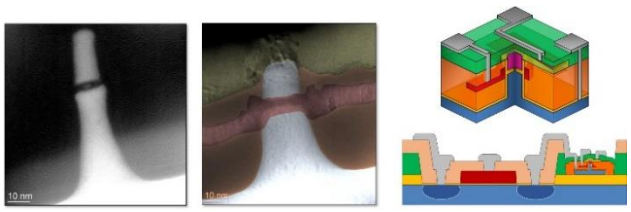

Figure 2: Single electron transistor based on a vertical silicon nanopillar with an embedded silicon nanocrystal