

## A 300mm Silicon Spin Based Platforms for Quantum Computing

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Semiconductor (Si and Ge) electron/hole spin-based qubits are considered as one of the most promising physical implementations of Quantum Computing qubits due to their inherent large coherence times [1] and compatibility with CMOS processing, offering scalability perspectives.

The research of Si and Ge spin qubits fabrication migrated rather fast from academic environment, where the ground-breaking milestones were reached, see e.g. in [2,3,4] to semiconductor manufacturing research [5,6]. The state-of-the-art 300mm CMOS based semiconductor qubits processing uses either advanced BULK/FIN CMOS [7] or SOI CMOS [8].

We present a comprehensive description of imec's 300mm Si spin qubit integration platforms which we use to study the fundamental aspects of the qubits. The qubits process flow features either 3 levels of overlapping poly-Si or TiN gates, patterned either by 300mm e-beam or optical lithography and subtractive dry etch or only single level of poly-Si or TiN gates patterned by optical lithography. These are used to form the basic qubits building blocks, i.e. Quantum dots (QDs) and Single Electron Transistors (SETs). DUV optical lithography is used for Junction formation, patterning of TiN or Al antennas for Electron Spin Resonance (ESR) or Cobalt micromagnets for Electric Dipole Spin Resonance (EDSR) based spin control. Intentionally, no isolation scheme is used. To minimize the magnetic noise in the vicinity of the spin qubit, epitaxy processes were developed for  $^{28}\text{Si}$  and  $^{28}\text{SiGe}$  heterostructure which allow us to fabricate both  $^{28}\text{SiMOS}$  qubits in which the qubits are located directly at the  $\text{SiO}_2/\text{Si}$  interface as well as  $^{28}\text{SiGe}$  devices in which electrons reside in the Si Quantum Well (QW) created by growing a thin  $^{28}\text{Si}$  layer between two  $^{28}\text{SiGe}$  strain relaxed layers.

Poly gates  $^{28}\text{SiMOS}$  qubits fabricated by our process exhibits record single and 2 gates fidelities among reported 300mm made qubits.

### References

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