Record carrier mobility in group IV semiconductor materials.

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Holes in strained Ge/SiGe heterostructures have emerged as a leading platform for spin qubits and hold promise for hybrid semiconductor-superconductor devices [1]. We recently departed from the mainstream approach and started epitaxy directly from Ge rather than Si substrates. With this strategy we reduce substantially the lattice mismatch between the substrate and the active layers of the heterostructure. As a result, we demonstrated an order of magnitude reduction of threading dislocations and a 10x boost in 2D hole gas mobility due to suppression of short range scattering [2]. Carrier mobility is a key qualifier of static disorder of the semiconductor material host. In this talk, I will focus on the latest experiments aimed at mitigating scattering from remote impurities, by positioning the quantum well at an increased distance from the semiconductor-dielectric interface. We demonstrate a reproducible mobility exceeding 4.5 millions cm^2/Vs over several heterostructure field effect transistors and observe a plethora of fractional quantum hall states which survive to low density [3]. The achieved mobility sets a new benchmark for any type of carriers (holes/electrons) in group IV semiconductor material stacks. We use this heterostructure as a testbed to identify the remaining scattering mechanisms affecting 2D hole transport, underlining a path forward to further reduce disorder and improve materials for hole spin qubits.

References

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