Tunable strains in Ge/Si heterostructures and nanowires for quantum computing applications

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Among all semiconductor-based quantum technologies, germanium has been identified as a strong candidate for quantum information processing due to its long coherence time of spins of localized holes, its capacity to accommodate superconducting pairing correlations, and its compatibility with CMOS technology. Recent research has shown that strained Ge quantum well growth on Ge/ Si_xGe_{1-x} planar heterostructures and in Ge/Si nanowires is essential for maximizing the mobility charges properties in these structures.

In this study, we grew 2D and 1D structures using chemical vapor deposition (CVD): planar heterostructures with variable Si_xGe_{1-x} barriers and a Ge QW, as well as Ge-Si core-shell nanowires for quantum computing. We localized Ge and Si chemically and structurally using EDX spectroscopy and STEM. Strain analysis of the Ge QW and core-shell interfaces was conducted using GPA and µ-Raman spectroscopy. These methods allowed for precise calculation and mapping of in-plane and out-of-plane strains in planar heterostructures and nanowires. By manipulating the core-shell diameter ratio in 1D structures and Si_xGe_{1-x} composition in 2D structures, we demonstrated and measured tensile/compressive strains in the interfaces, making our material suitable for integration in Si platforms for quantum computing.