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Optimizing silicon locking layer overgrowth for high-quality phosphorus-doped delta layers[1] XIQIAO WANG, Univ of Maryland-College Park, JOSEPH HAGMANN, PRADEEP NAMBOODIRI, JONATHAN WYRICK, KAI LI, ROY MURRAY, M.D. STEWART, JR, CURT RICHTER, RICHARD SILVER, National Institute of Standards and Technology — Doped semiconductor structures with ultra-sharp dopant confinement, minimal lattice defect density, and high carrier concentrations are highly desirable in the development of both ultra-scaled conventional semiconductor devices and emerging all-silicon quantum computer architectures. We present a systematic investigation using low temperature locking layers to suppress dopant segregation and diffusion while optimizing dopant confinement, epitaxial growth quality, and transport properties of 2D phosphorus-doped layers. We use secondary ion mass spectroscopy (SIMS), scanning tunneling spectroscopy (STM), transmission electron spectroscopy (TEM), and low-temperature transport measurements to fine-tune the locking layer thickness, growth rate, and thermal anneal to elucidate their respective roles in optimizing the delta layer quality. The dopant segregation and diffusion properties under different locking layer growth conditions were further studied in detail by modeling dopant segregation and diffusion along with implementing a convolution procedure to correct SIMS profiles.

[1]Innovations in Measurement Science (IMS) project at NIST: Single atom transistors to solid states quantum computing.

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