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A promising approach for monolithic integration of III-V semiconductors on Si

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III-V semiconductors have been a topic of technological interest owing to their intriguing properties like high carrier mobility and direct fundamental bandgap. Si, on the other hand forms the backbone of electronic engineering but is an indirect bandgap semiconductor. The idea here is to integrate both III-V material and Si on a single platform with high structural quality and excellent optoelectronic properties. This comes with a number of challenges as both Si and III-V semiconductors are heterogeneous material due to mismatches in lattice constants, thermal expansion coefficients, different lattice symmetries and different polarities at the heterojunction. As a result, the material can possess several crystal defects which can degrade the performance of the device. We use a distinctive approach, "nanoheteroepitaxy", to grow high quality, defect free III-V materials selectively on Si nanotips patterned substrates. It allows growth on well-defined areas on the substrate, leads to limited surface contact, and enables elastic relaxation of strain. We present the selective epitaxial growth of InP and GaP using Gas Source Molecular Beam Epitaxy on arrays of Si nanotips with different openings, ranging from 8 nm to 62 nm and pitch distance varying from 0.5 µm x 0.5 µm to 2 µm x 2 µm, embedded in SiO2 matrix. Our approach brings freedom in tailoring the III-V material and leads to a myriad of opportunities to investigating III-V/Si selective growth, and realization of efficient optoelectronic devices on the Si platform.

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