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Epitaxial Growth of InP-Based Semiconductors for Ultra-High-Speed Electronics

NTT

Motivation

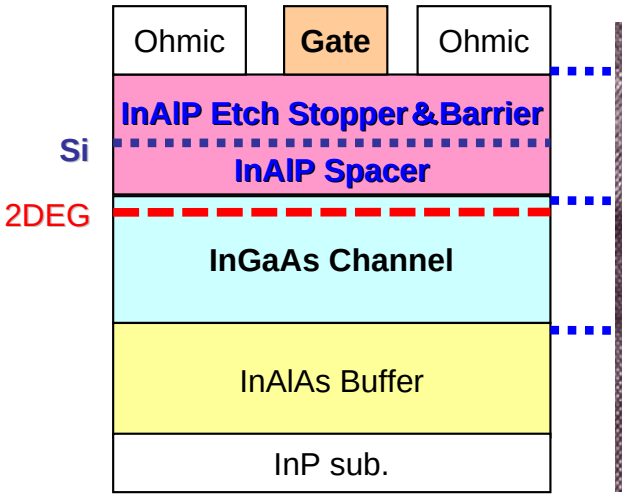
Millimeter-wave frequencies of over 100 GHz are attracting much interest for use in many technical fields, such as broadband wireless communications, sensing and monitoring. The excellent high-frequency characteristics of InP-based high electron mobility transistors (HEMTs) have been demonstrated in these applications. A critical issue as regards further improvement of the high-speed characteristics of HEMTs is the reduction of the Schottky barrier thickness. There is a strong need for simple fabrication processes that reduce thickness.

Originality

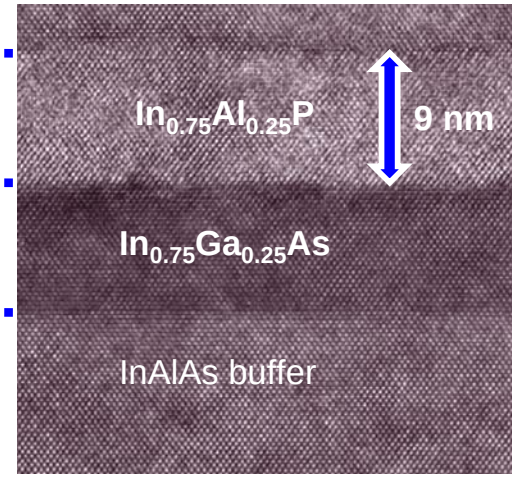
InAlP/InGaAs heterojunctions have been developed for use as modulation-doped (MD) structures in HEMTs by using metal-organic vapor-phase epitaxy (MOVPE). Thin InAlP layers grown directly on the InGaAs channel act as a recess-etching stopper, Schottky barrier, and spacer, and effectively reduce the total gate-channel distance. By optimizing the growth conditions, high-quality InAlP/InGaAs heterojunctions were successfully fabricated. Practical wet-etching selectivity was obtained even in 2-nm-thick ultra-thin InAlP etching stoppers. These results indicate the excellent abruptness and flatness of atomically-controlled heterointerfaces.

Impact

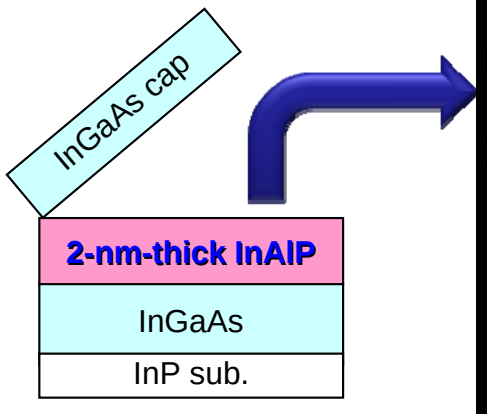
This technology will boost the HEMT operating speed toward the THz range and contribute to future high-performance communication systems.

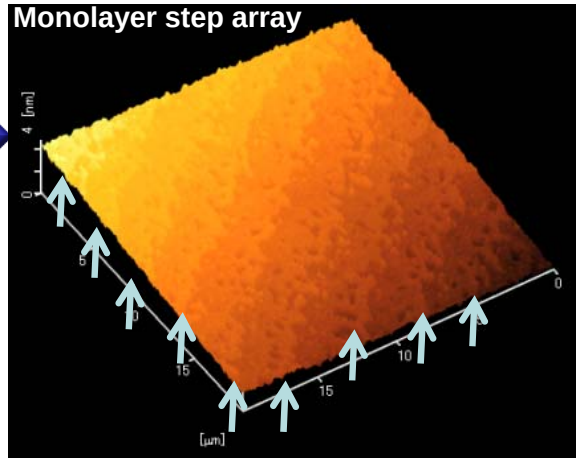


InAlP/InGaAs HEMT
Ns=1.8x10^{12} cm^{-2}
Mobility > 10,000 cm^2/Vs



Cross-sectional TEM image





Typical surface morphology of 2-nm-thick InAlP selective-etching stopper after removing InGaAs cap layer

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