GENERATION AND CONTROL OF COHERENT ACOUSTIC PHONONS IN InGaN MULTIPLE QUANTUM WELLS

Ümit ÖZGÜR, Chang-Won LEE, and Henry O. EVERITT*

Department of Physics, Duke University, Durham, NC 27708

Sub-picosecond, wavelength-degenerate differential transmission (DT) measurements were performed on a 10-period $In_{0.05}Ga_{0.95}N/In_{0.15}Ga_{0.85}N$ multiple quantum well (MQW) structure grown by MOCVD on a double-polished sapphire substrate. In a one-pump one-probe DT arrangement, the wavelength of the degenerate pump/probe pulse was tuned through the barrier energy to measure the carrier capture time from the barrier states to confined quantum well states. Carriers injected near the barrier band edge were quickly captured into the quantum wells, within 310-540 fs at room temperature, and impulsively generated coherent zone-folded longitudinal acoustic phonon (ZFLAP) oscillations. The observed oscillation frequency, 0.69 THz, revealed a sound velocity of about 8300 m/s in the MQW region.

The wavelength and temperature dependence of these ZFLAP oscillations was investigated. The oscillations were observed to produce the strongest optical modulation when probed near the barrier absorption edge, a consequence of the quantum confined Franz-Keldysh effect arising from the intrinsic piezoelectric field in the quantum wells.

Two-pump DT was used to generate and control coherent ZFLAP oscillations through the relative timing of the two pump pulses. Enhancement and suppression of ZFLAP oscillations were demonstrated, including the complete cancellation of generated acoustic phonons for the first time in any material system. Coherent control was used to demonstrate that ZFLAPs are generated differently in InGaN MQWs than in GaAs/AlAs superlattices.

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