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Propagating Optical Phonon Modes and Their Electron-Phonon Interaction Hamiltonians in Asymmetric Wurtzite Nitride Semiconductor Quantum Wells

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Abstract: Within the framework of the dielectric continuum model and Loudon's uniaxial crystal model, the properties of frequency dispersion of the propagating (PR) optical phonon modes and the coupling functions of electron-PR phonons interaction in an asymmetrical wurtzite quantum well (QW) are deduced and analyzed via the method of electrostatic potential expanding. Numerical calculation on an asymmetrical $Al_{0.25}Ga_{0.75}N/GaN/Al_{0.15}Ga_{0.85}N$ wurtzite QW were performed. The results reveal that there are infinite branches of PR phonon modes in the systems. The behaviors of frequency forbidden of PR modes in the asymmetric QWs have been clearly observed. The mathematical and physical origins for these features have been analyzed in depth. The PR optical phonon branches have been distinguished and labelled reasonably in terms of the oscillating properties of the PR modes in the well-layer material. Moreover, the amplitudes and frequency properties of the electron-PR modes coupling functions in the barrier and well materials have also been analyzed from both of the mathematical and physical viewpoints.

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