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Crystallographic Orientation Effect On Hole Polar Optical Phonon Scattering Rates in Thin Gaas/Al_xga_{1-X}as Quantum Wells

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Abstract

We report on hole polar optical phonon scattering processes in thin GaAs/**$Al_xGa_{1-x}As$ quantum** wells grown in various crystallographic directions, such as [001], [110]. Using the dielectric continuum model we focus on how the different scattering processes of holes with interface phonon modes depend on the initial hole energy. In our work, we use the Luttinger-Kohn (LK) 6×6 **k.p** Hamiltonian with the envelope function approximation, from which we compute numerically the electronic structure of holes for a thin quantum well sustaining only one bound state for each type of hole. Due to mixing between the heavy, light, and split off bands, hole subbands exhibit strong nonparabolicity and important warping that have their word to say on physical properties. Detailed and extensive calculations that the rates for intra-subband scattering processes differ significantly from those of bulk *GaAs* because of quantization and reduced dimensionality. Moreover, the study of scattering as a function of hole energy shows that the trend of the scattering rates is governed mostly by *i)* overlap integrals and *ii)* the density of the final states to which the hole scatters. The influence of warping, in the hole energy dispersion, on the phonon scattering rates is also explored and found to be important when the initial hole energy is high. Our calculations show evidence of strong anisotropy in the scattering rates especially for processes involving the heavy hole subband, which anisotropy is in fact quite important and far from being negligible. However, strain effect can reduce scattering rates.
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Keywords: anisotropy, Dielectric Continuum Model, strain, subband, warping