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Coherent phonons in semiconductor superlattice under DC electrical bias

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Resonant pumping of superlattices SLs by femtosecond laser pulses results in the generation of coherent phonons with frequency centred approximately on \textit{s}/\textit{d_{SL}}, where \textit{s} is the speed of longitudinal sound and \textit{d_{SL}} is the SL period. The phonons can be detected by measuring the changes in reflectance of time-delayed probe pulses. To date, measurements have been made on nominally undoped SLs, and phonon frequencies are typically in the range 100 GHz - 1 THz. The motivation for these studies is that such hypersound could be used for acoustic probing of nanostructures. Here we describe the generation and detection of coherent phonons in a doped and electrically-biased SL. The studied SL consisted of 50×(6 nm GaAs and 4 nm AlAs), uniformly doped with Silicon to density 2{\times}10^ {22}m^ {-3}. Pump-probe measurements were made at {\lambda}∼770 nm on an optical MESA at \textit{T}=12K. At zero bias, we observed a similar phonon spectrum as previously observed in comparable but undoped SLs, with a mode at ∼ 450GHz. Under applied bias this mode increased in amplitude, and the decay time was also increased. We discuss these observations in terms of the effects of the bias on the coherent phonon generation and detection process and also the possibility of coherent phonon amplification occurring in the structure.