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The Influence of Phonons and Phonon Decay on the Optical Properties of GaN D. Y. SONG, M. BASAVARAJ, S. A. NIKISHIN, M. HOLTZ, Texas Tech University, Lubbock, Texas 79409, V. SOUKHOVEEV, A. USIKOV, V. DMITRIEV, TDI, Inc., 12214 Plum Orchard Dr., Silver Spring, MD 20904 — The temperature dependences of vibrational and optical properties of high-quality GaN are studied using Raman and photoluminescence (PL) spectroscopies in the range 20 to 325 K. The Raman-active A_1(LO) phonon has temperature dependence described well by combined two- and three-phonon decay. The temperature dependences of E_2^2phonon are almost entirely dominated by the thermal expansion, and the contribution of three-phonon decay process is very small throughout interested temperature range. The shallow neutral donor-bound exciton (D^0,X) and two free excitons (X_A and X_B) are observed at low temperatrue PL spectra. Also seen are two A_1(LO) phonon sidebands (PSBs), originating from the X_B free exciton, with the characteristic asymmetry attributed to interactions between discrete and continuum states. Analysis of the band-edge excitons reveals that energy gap shrinkage and exciton linewidths are completely described based on electron-phonon interactions with phonon properties consistent with the Raman analysis. First and second PSBs have temperature dependence associated with the A_1(LO) phonon. The shift, broadening, and asymmetry of the PSBs are explained by Segall-Mahan theory adding the decay mechanism of A_1(LO) phonon and the exciton broadening from electron-phonon interactions. Work at Texas Tech University supported by National Science Foundation grant ECS-0323640.

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