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Influence of ordering on optical properties of InGaP layers grown on GaAs and Ge substrates

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InGaP material, which is one of the ternary semiconductor alloys, has been widely studied for optoelectronic device applications including light emitting diodes, laser diodes, and solar cells. Expecially, InGaP ternary alloys grown on Ge substrates becomes more important for the solar cell applications. In this kind of ternary semiconductor alloys the E_g depends on the ternary composition, strain and ordering for both lattice matched and mismatched structures. The ordering effect on the band-gap energy and the composition modulation effect have been reported for InGaP films on GaAs substrates depending on growing parameters of the alloy films. In this work, we report the effect of ordering on the optical properties and the decay lifetime of InGaP grown on both GaAs and Ge substrates by photoluminescence (PL), PL excitation, and time-resolved photoluminescence (PL) measurements. The 1μm thick $In_xGa_{1-x}P$ thin films were grown on GaAs and Ge substrates with varying growing parameters such as growth temperature, growth rate, and V/III ratio. The 0.3μm thick GaAs layer was used as a buffer layer. The composition of InGaP materials was determined by high resolution x-ray diffraction. PL measurement was carried out using 532 nm cw laser with 7 mW power at low temperature and room temperature to determine the ordering effects of the grown InGaP samples. The PL peak energy of more ordered InGaP samples shows a shift to lower energy. With increasing excitation power, the emission peaks are blue-shifted because of the localization effects. The time-resolved PL measurement was done to measure the radiative and non-radiative recombination life time at low and room temperatures. Based on time-resolved PL results, we will discuss different contributions to the change in decay times caused by carrier localization due to the ordering effect and/or by different crystal quality due to the presence of defects.