The Effects of N Incorporation in GaAsSb based Core-shell Nanowires

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Bandgap tuning beyond 1.3 μm in GaAsSb nanowires (NWs) can be achieved using dilute amounts of nitrogen. Incorporation of nitrogen in the GaAsSb shell is studied in order to reduce the bandgap energy for realizing nanoscale optoelectronic devices in the telecommunication wavelength region. In this report, varying N incorporation in the GaAsSbN shell is realized by changing the N-plasma pressure. High density of vertical GaAsSb(N) core-shell configured nanowires are grown on Si (111) substrates using plasma assisted molecular beam epitaxy. The growth duration of the nitride shell was optimized to produce high photoluminescence (PL) intensity. Effects of N incorporation on the morphology of NWs were studied to optimize a closely lattice-matched core-shell material configuration. Evolution of N-induced band tail states in the PL emission has been correlated with increase in growth duration under N-plasma. Rapid thermal annealing at different temperatures was carried out to understand the nature of N-induced defects. Changes in peak positions and line shapes in the Raman spectra of annealed samples have been used to ascertain the nature of the defects being annihilated during the growth. Study of structural quality of dilute nitride NWs using transmission electron microscopy will also be presented. This systematic study reveals that the morphology and optical characteristics of the nitride nanowires can be significantly improved by appropriate lattice matching with the non-nitride core.

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Supplementary Information

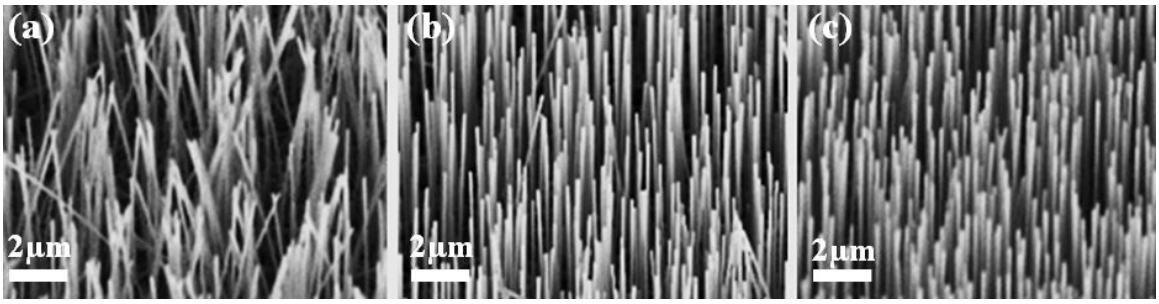

Figure 1. Scanning electron microscope images of GaAsSb/GaAsSbN nanowires under (a) low (b) medium and (c) high nitrogen plasma pressure.

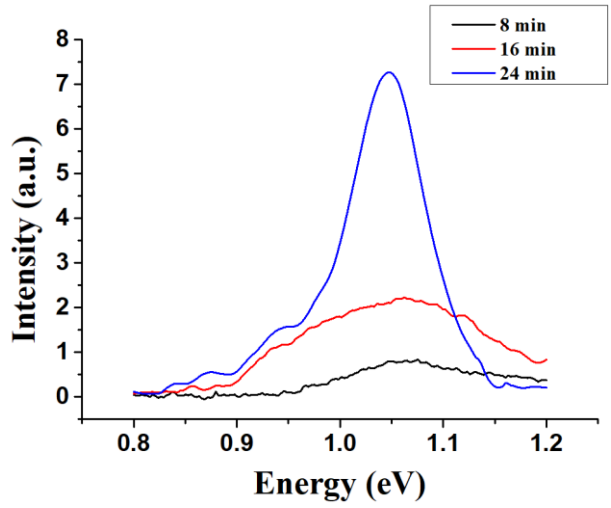

Figure 2. Variation in intensity and FWHM of photoluminescence spectra with duration of N-plasma.

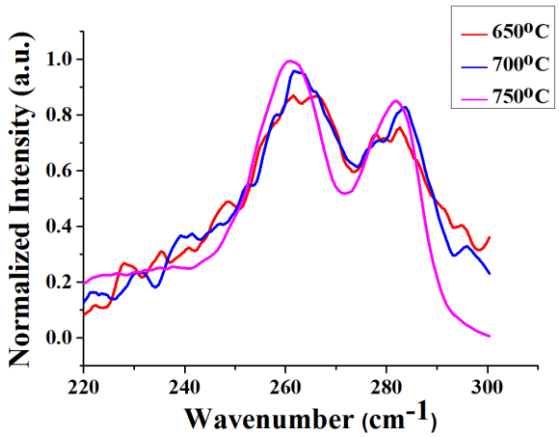

Figure 3. Raman spectra of NWs annealed at different temperatures.