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Development of AlGaN cladding layer for GaN second harmonic generation structure

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In recent years, quite considerable amount of research has been focused on GaN as a novel material for nonlinear optics and photonics. A unique combination of i direct band gap, large transparency window and high second order nonlinearity makes GaN an interesting candidate for nonlinear optics [1]. In addition, GaN films can further be structured to fabricate waveguides, microrings, microdiscs and photonic crystal nanocavities for light conversion applications [2,3].

Efficient frequency conversion requires a phase-matching condition to compensate for material dispersion. Phase matching can be achieved by exploiting the birefringence exhibited in anisotropic crystals or artificial structures. Quasi-phase-matching (QPM) utilizes spatially periodic modulation of nonlinear coefficients and has achieved great success due to its versatility in material choice and pump frequency range [4]. Other phase-matching methods, such as modal-dispersion phase matching (MDPM) have been achieved in single-waveguide structures [reiketu citavimo]. Looking forward extending methods like coupling compensation-quasi-phase-matching (C-QPM) [reiketu citavimo] are foreseen, also for GaN.

In this work, we present modeling, growth results and ideas how to achieve structures for second harmonic generation by using QPM and MDPM phase matching methods. Modeling results present that IInd harmonic conversion efficiency is much greater using two polarity GaN layers than only one. Growth parameter optimization of AlGaN layers on AlN was performed using Aixtron Close-Coupled-Showerhead 3x2 MOCVD reactor. Substantial work was performed to align the overgrown AlGaN layer quality with the underneath grown and annealed AlN layer. Al concentration in AlGaN layers was 65% ÷ 67%, estimated using X-ray diffraction (XRD). AlGaN layer serves as a cladding layer for GaN waveguiding layer, because of smaller refractive index for AlGaN than GaN. Surface morphology and roughness investigations of AlGaN layer performed by Atomic Force Microscopy, resulted the smoothest surface when grown at high temperatures (about 1130^{o}C) on the optimized AlN layer. Discussion on structure preparation for second harmonic generation will follow the presentation.

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