Reflectivity of plasmon–phonon modes in grating-coupled AlGaN/GaN heterostructures grown on SiC and GaN substrates

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During last decade, the properties of electron plasma and lattice oscillations have been widely investigated in polar semiconductors GaAs and AlGaAs [1] and heterostructures such as GaAs and InGaAs [2], GaN and AlGaN alloys [3-4]. Gallium nitride (GaN) is one of the most promising materials encouraging rapid development of THz devices.

In this research, the reflection spectra of the grating-coupled AlGaN/GaN heterostructures grown on SiC and GaN substrates were investigated with the aim to describe the interaction between grating and phonon modes for efficient electromagnetic radiation coupling in the semiconductor.

Two samples were fabricated for the experiment. The first sample consisted of 26/1000 nm thick $Al_{0.19}Ga_{0.81}$/GaN (with 19% of Al) heterojunction which was grown on the bulk GaN *n*-type Ammono substrate. Grating with the period of 16 um was fabricated on the surface of heterojunction depositing Ti/Au metals by using standard UV photolithography procedures. For the second sample, a 28/1000 nm thick $Al_{0.25}Ga_{0.75}$/GaN heterojunction was grown on 500um thick 6HSiC substrate. In this a case, the period of the grating-coupler was of 7 um.

The reflection spectra were measured using Far Infrared Fourier Transform (FTIR) spectrometer over the frequency range of 400-1500 cm-1. The reflectivity was calibrated using the reflectance spectrum of a gold film. Experimental results were interpreted with the calculated spectra which were modeled using Rigorous Coupled Wave Analysis method.

The first grating-coupled sample demonstrated two plasmon modes in the spectrum indicating efficient plasmons-phonons interaction. The reflection of the second grating-coupled sample demonstrated more complex reflectivity with up to five peaks of plasmon–phonon modes in the spectrum. In the case of the second sample, it was observed, that plasmons interact with phonon modes of GaN heterojunction layers and SiC substrate.

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