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Observation of 2D plasmon THz radiation in AlGaN/GaN heterostructures using modulation spectroscopy

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2D plasma oscillations present in semiconductor inversion layers have been employed for various applications in the THz range such as THz detection, generation, and amplification [1]–[4]. The THz plasmonic solutions help to overcome the problem of tunable phase shifters and beam modulators [5], [6]. Besides graphene-based plasmonic THz devices, the gating-gated AlGaN/GaN high electron mobility transistor (HEMT) structures were found to be suitable to support 2D plasma oscillations up to room temperature [7]. The resonant frequency of 2D plasmons is tuned by varying screened-electron density under the biased gate in a range of few orders until device switches to the unscreened plasma modes in THz spectrum [4], [8]. The biasing of plasmonic devices via source-drain (SD) terminals, usually employed for the research of THz emission spectra [3], was also proposed recently for the investigation of modulated reflection spectra of 2D plasmons in AlGaN/GaN HEMT structures [9], [10]. However, the change of transmission and reflection spectra under SD bias were not studied in detail.

In this work, the spectral characteristics of grating-gated AlGaN/GaN HEMT structures were measured experimentally by applying bias voltages either to gate-source (V_{GS}) or to SD (V_{SD}) terminals. The shift of 2D plasmon peak by SD voltage was found to be similar to shift by gate-source voltage. This effect was studied using modulation spectroscopy of 2D plasmons placing the sample in reflection and transmission geometry of THz-TDS system. A comprehensive analysis of absolute and relative spectra with modulation spectroscopy characteristics revealed the appearance of spectral features in modulated emission spectrum of electrically driven 2D plasmons in AlGaN/GaN HEMT structures.

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