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Electrically controlled THz plasmon resonances in large surface AlGaN/GaN grating-gate structures

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We report on the technology and THz spectroscopy of 2D plasmonic devices based on high density two-dimensional electron plasma in AlGaN/GaN semiconductor heterostructures. The devices were fabricated in the geometry of field effect transistor (FET). For the efficient coupling between long wavelength THz radiation and short wavelength 2D plasma waves, the special metallic, periodic grating-gate couplers were processed, replacing the usual antenna couplers used for sub-micron FET gates. With the developed, advanced technology it was possible to realize large surfaces of the devices (up to 4 mm2) with good gate control and negligible gate leakage currents, as proven by magnetooptics and magnetotransport studies [1].
THz plasmon resonances were studied by Fourier Transform Infrared Spectroscopy in a wide temperature range from 4.2 K to 300 K. We show that the base mode frequency of the investigated plasmon resonances lies in THz frequency range between 0.5 THz and 2.0 THz, depending on the electron plasma density and the period of the grating-gate coupler. Therefore, the plasmon frequency can be easily electrically tuned by the voltage applied to the grating-gate electrode and, in this way, changing the 2D electron density. The electrical control of the resonance frequency was realized even at room temperature. These results are promising for the development of plasmonic devices, that arouse great interest as potential resonant THz modulators, filters, detectors, and emitters with electrically controlled operating frequency.
[1]. P. Sai, S. O. Potashin, M. Szoła, et al., Phys. Rev. B 104, 045301, 2021

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