Power Gain at THz Frequencies Employing Grating-gate RTD-gated HEMTs

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Over the past decades, the THz frequency regime has become the subject of much attention due to its wide range of applications in diverse areas such as astronomy, imaging, spectroscopy, communications, and so on. Although significant progress has been recently achieved, there is still a need for devices efficiently operating at these frequencies, for instance, devices enabling THz power amplification. In this context, resonant tunneling gated high-electron mobility transistors (RTD-gated HEMTs) have been recently proposed as devices capable of producing power gain at THz frequencies. In these devices, the power gain originates due to the interplay between: (i) electron plasma waves, which are excited in the HEMT two-dimensional electron gas (2DEG), and (ii) resonant tunneling, which occurs when electrons tunnel from the gate-electrode to the 2DEG because of the device gate-stack being a double-barrier hetero-structure. Previous theoretical work on these devices, employing antenna fed configurations, predicts the potential of achieving power amplification with a gain exceeding 5 dB in the GaN materials system (Sensale-Rodriguez et al., IEEE Trans. THz. Sci. Tech. 3(2), 200-206, 2013). This work discusses the THz power amplification in GaN-based grating-gate RTD-gated HEMTs. In these structures, THz radiation is coupled into plasmons in the active region of the device via the grating-gate itself, rather than by an antenna structure as in our previous work. These plasmons are then amplified as they travel through the RTD-gated 2DEG in the HEMT structure. When analyzing by means of numerical simulations the re-radiated THz radiation by the structure, upon an initial THz excitation, power amplification with gains > 30dB are observed.