Graphene has attracted considerable attention due to its massless and gapless energy spectrum. This lecture reviews recent advances in the research of 2D electronic and plasmonic terahertz (THz) devices based on graphene-based 2D materials, particularly highlighting the THz sources and detectors. Carrier-injection pumping of graphene can enable negative-dynamic conductivity in the terahertz (THz) range, which may lead to new types of THz lasers. The dual-gate graphene channel transistor (DG-GFET) structure serves carrier population inversion in the lateral p-i-n junctions under complementary dual-gate biased and forward drain biased conditions, promoting spontaneous incoherent THz light emission. A laser cavity structure implemented in the active gain area can transcend the incoherent light emission to the single-mode lasing. We designed and fabricated the distributed feedback (DFB) DG-GFET. A teeth-brash-shaped DG structure is introduced as the DFB cavity having the fundamental mode at 4.96 THz. Broadband rather intense (~10–100 μW) amplified spontaneous emission from 1 to 7.6 THz and weak (~0.1–1μW) single-mode lasing at 5.2 THz were observed at 100K in different samples. When the substrate-thickness dependent THz photon field distribution could not meet the maximal available gain-overlapping condition, the DFB cavity cannot work properly, resulting in broadband LED-like incoherent emission. To increase the operating temperature and lasing radiation intensity, further enhancement of the THz gain and the cavity Q factor are mandatory. Plasmonic metasurface structures promoting the super-radiance and/or instabilities as well as double-graphene-layered (DGL) van der Waals heterostructures promoting photon/plasmon-assisted resonant tunneling are promising for giant THz gain enhancement. In terms of THz detection, nonlinear nature of graphene plasmons as well as photon/plasmon assisted resonant tunneling in the DGL enable drastic enhancement of detection responsivity that can well outperform any existing room-temp. fast detectors.
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