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TERAHERTZ LIGHT EMISSION AND LASING IN GRAPHENE UNDER CURRENT-INJECTION PUMPING

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Graphene has attracted considerable attention due to its massless and gapless energy spectrum. 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 current-injection pumping, 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. The DG forms the DFB cavity having the fundamental mode, modal gain and the Q factor of 4.96 THz, ~5 cm^{-1}, and ~240, respectively. THz emission from the sample was measured using a Fourier-transform spectrometer with a 4.2K-cooled Si bolometer. Broadband rather intense (~10~100 μW) amplified spontaneous emission from 1 to 7.6 THz and weak (~0.1~1 μW) 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 van der Waals heterostructures promoting photon/plasmon-assisted resonant tunnelling are promising for giant THz gain enhancement.

Biography

Taiichi Otsuji is a Professor at the Research Institute of Electrical Communication (RIEC), Tohoku University, Japan. He has received the PhD degree in Electronic Engineering from Tokyo Institute of Technology, Tokyo, Japan in 1994. He has worked at the NTT Labs from 1984 till 1999, Kyushu Institute of Technology from 1999 to 2005, and Tohoku University since 2005. He has authored and co-authored more than 240 peer-reviewed journal papers. He has been an IEEE Electron Device Society Distinguished Lecturer in 2013. He is a Fellow of the IEEE, a Senior Member of the OSA, and a Member of the JSAP, MRS, and IEICE.

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