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Single-mode terahertz lasing in current injection graphene channel transistor

Optical and/or injection pumping of graphene can enable negative-dynamic conductivity in the terahertz (THz) spectral range, which may lead to new types of THz lasers. In the graphene structures with p-i-n junctions, the injected electrons and holes have relatively low energies compared with those in optical pumping, so that the effect of carrier cooling can be rather pronounced, providing a significant advantage of the injection pumping in realization of graphene THz lasers. We fabricated a distributed-feedback (DFB) dual-gate graphene-channel transistor as a current-injection terahertz laser. A pair of teeth-brash-shaped gate electrode was patterned to form a DFB cavity in which the active gain area and corresponding gain coefficient are spatially modulated. A single mode emission at 5.2 THz was observed at 100 K beyond the threshold carrier injection level. The single mode emission exhibits a non-monotonic threshold-like behavior with the highest intensity ~10 μW, reflecting the carrier over-cooling effect under weak pumping. Spectral narrowing with increasing the carrier injection around the threshold was also observed. The result is still preliminary level but the line width fairly agrees with calculation based on DFB-Fabry-Perrot hybrid-mode modeling.

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 since 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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