Title: Graphene Metadevices for THz Applications

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Curriculum Vitae

Current status
Associate Professor, Mechanical Engineering, KAIST

Professional experiences
Editorial Board Member, Scientific Reports, Nature Publishing Group (NPG), 2013 – Present
Editorial Board Member, Advanced Optical Materials, Wiley, 2015 – Present
Editorial Board Member, Applied Physics A, Springer, 2015 – Present
Editorial Board Member, KAIST Research Series, Springer, 2014 – Present
Co-chair, Technical Sub-Program Committee (Nanophotonics), NANO KOREA 2015
Technical Program Committee, The 9th International Congress on Advanced Electromagnetic Materials in Microwaves and Optics (Metamaterials’2015)
Technical Program Committee, Integrated Photonics Research, Silicon and Nano Photonics (IPR 2015)
Technical Program Committee, The 5th International Topical Meeting on Nanophotonics and Metamaterials (NANOMETA-2015)
Chair of Technical Program Subcommittee (Micro- and Nanophotonics), The 11th Conference on Lasers and Electro-Optics Pacific Rim (CLEO-PR 2015)
Technical Program Committee, The 8th International Conference on Advanced Materials and Devices (ICAMD 2013)
Technical Program Committee, The 6th International Conference on Nanophotonics (ICNP 2012)
Graphene, a two-dimensional, carbon allotrope bonded in a honeycomb lattice, can provide a possible pathway that would improve the functionality of terahertz optoelectronics. Compared to semiconductors, a higher doping of graphene is possible in principle, even at room temperature. Single-layer graphene has a linear dispersion without a bandgap, so its carrier shows much faster mobility than that in conventional semiconductors [1]. It has been demonstrated that graphene-based optoelectronic devices are feasible and that sometimes they can be superior to conventional semiconductors for application in the terahertz frequency range. For example, graphene-based metamaterial terahertz modulators, due to their large tuning properties, provide better modulation depth in terahertz transmissions [2].

The graphene ferroelectric metadevices can be configured to show electrically-controlled nonvolatile memory operations in terahertz wave transmission. The memory operation can be observed in a graphene metamaterial due to the hysteretic behaviour of charge density in graphene with a variation in gate voltage [2]. However, this intrinsic hysteresis of CVD-grown graphene is not strong enough for the device to show non-volatile memory operation (retention time of ~20 minutes). Therefore, we replace the dielectric spacer with a ferroelectric layer of P(VDF-TrFE) in order to make the active graphene metadevices nonvolatile [3]. When being poled by electric gating, the ferroelectric layer provides long-lasting polarization states by which charge carriers in graphene layer can be controlled. Thus, two polarization states in the ferroelectric result in two distinct doping levels of graphene and lead to bistable states of terahertz wave transmission that last over $10^5$ seconds.

3. “Graphene-ferroelectric metadevices for nonvolatile memory and reconfigurable logic-gate operations”, Nature Communications, in press