Seminar announcement

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"Tracking ultrafast intrinsic optical-to-electrical conversion dynamics in graphene"

Ultrafast and energy-efficient optical-to-electrical (O-E) conversion is a crucial element for high-speed data communication for the next generation of telecom and datacom. Graphene photodetectors (PDs) working with the photothermoelectric effect are promising platforms because of zero dark current operation and ultrafast carrier energy relaxation. However, although the expected operating speed exceeds 200 GHz, the experimentally measured 3 dB bandwidth has been limited to around 70 GHz [1].

In this talk, I will show that the 3 dB bandwidth of graphene PDs indeed exceeds 200 GHz by overcoming bandwidth limitations by using on-chip THz spectroscopy [2–4] and zinc oxide (ZnO) gate structure without high-frequency capacitive coupling [5]. Furthermore, we thoroughly investigate non-local photocurrent dynamics while tuning the Fermi energy in several graphene samples with different carrier mobilities and channel lengths that are encapsulated in hexagonal boron nitride. As a result, we comprehensively understood the O-E conversion processes in graphene, including the microscopic mechanism of photovoltage generation, photocurrent transport, and photocurrent decay [6].

We believe that our results and methodology bridge the gap between ultrafast optical science and device engineering, and will accelerate ultrafast optoelectronic applications in various two-dimensional van der Waals materials and their heterostructures.

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[3] A. Brenneis et al., Sci. Rep. 6, 35654 (2016)
[4] K. Yoshioka et al., Appl. Phys. Lett. 117, 161103 (2020)
[5] N. H. Tu, K. Yoshioka et al., Commun. Mater. 1, 7 (2020)
[6] K. Yoshioka et al., Nat. Photonics (2022), https://doi.org/10.1038/s41566-022-01058-z

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