Kei Kinoshita[1]
Rai Moriya[1], Satoru Masubuchi[1], Kenji Watanabe[2], Takashi Taniguchi[2], and Tomoki Machida[1,3]
[1] Institute of Industrial Science, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan
[1] National Institute for Materials Science, 1-1 Namiki, Tsukuba, 305-0044, Japan
[3] CREST-JST, Japan

kkino@iis.u-tokyo.ac.jp

Detection of cyclotron resonance in graphene using Photo-Seebeck and photo-Nernst effects

We demonstrate the detection of a cyclotron resonance in Landau-quantized graphene under infrared light irradiation by utilizing photo-thermoelectric effect, which is significant in graphene because of its small electron heat capacity and large thermoelectric coefficient. Since photo-thermoelectric effect contains photo-Seebeck and photo-Nernst components and their symmetry are different, we achieved the selective detection of each component by carefully tuning the symmetry of device [1]. (1) Photo-Seebeck effect generates voltage along thermal gradient created under light irradiation. To detect this, we fabricated double back-gated h-BN/Gr/h-BN device as shown in Figs. 1(a) and 1(b). This creates asymmetric carrier density profile between left and right region of graphene. With the help of this asymmetric structure, we demonstrate infrared photodetection at zero-field [Fig. 1(c)]. (2) To detect photo-Nernst effect, a part of graphene is covered with metal mask to generate photo-induced thermal gradient perpendicular to the voltage probe as shown in Figs. 1(a) and 1(b). Unlike photo-Seebeck effect, photo-Nernst voltage is significant only under application of magnetic fields and its sign reversed upon a reversal of the magnetic field direction [Fig. 1(c)]. Importantly, both photo-Seebeck and photo-Nernst effect signal strongly enhanced at cyclotron resonance [Fig. 1(d)]. These results highlight possibility of high-sensitive infrared detection using photo-thermoelectric effect in graphene.

Reference

[1] K. Kinoshita, R. Moriya, M. Arai, S. Masubuchi, K. Watanabe, T. Taniguchi, and T. Machida, Appl. Phys. Lett. **113**, 103102 (2018). (Selected as Editor's picks of APL)

Figure

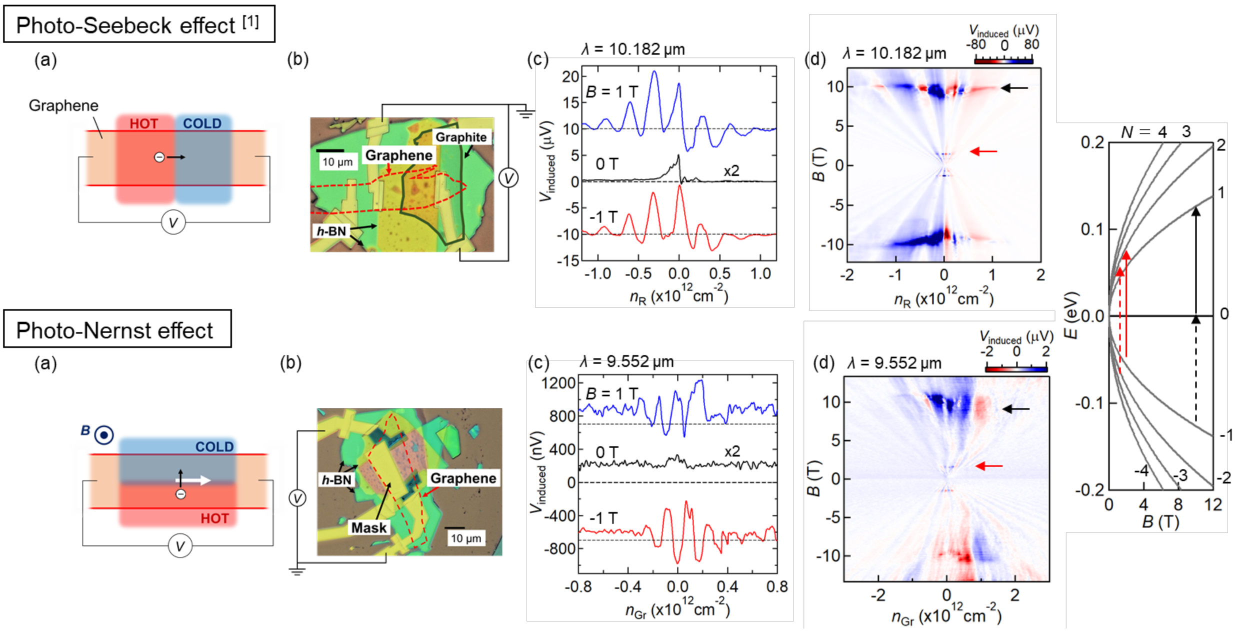

Figure 1: (Upper) Photo-Seebeck effect, (Lower) Photo-Nernst effect. (a) Experimental concept. (b) Optical micrograph of the device. (c) The photovoltage signal at low magnetic field. (d) Cyclotron resonance and Landau levels of graphene.