Supporting Information

Graphene-Bi_2Te_3 Heterostructure as Saturable Absorber for Short Pulse Generation

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1. Raman spectra of pure graphene and graphene-Bi_2Te_3 hetero-structure

The shift of characteristic peaks in Raman spectroscopy can provide an indirect evidence of interlay interaction between graphene and Bi_2Te_3. Specifically, we compared the Raman spectrum of the graphene-Bi_2Te_3 heterostructure sample with that of pure graphene sample, as shown in Figure S1. It is interesting to find that G peak shift from 1580 to 1598 cm^{-1}, and 2D peak shift from 2680 to 2652 cm^{-1}. The shift of G peak suggests an additional strain which originates from the slight lattice mismatch between graphene and Bi_2Te_3 after the formation of a heterostructure.[1] The change of 2D peak is correlated to the modification of the electronic structure in graphene after growing Bi_2Te_3 on it.[2]

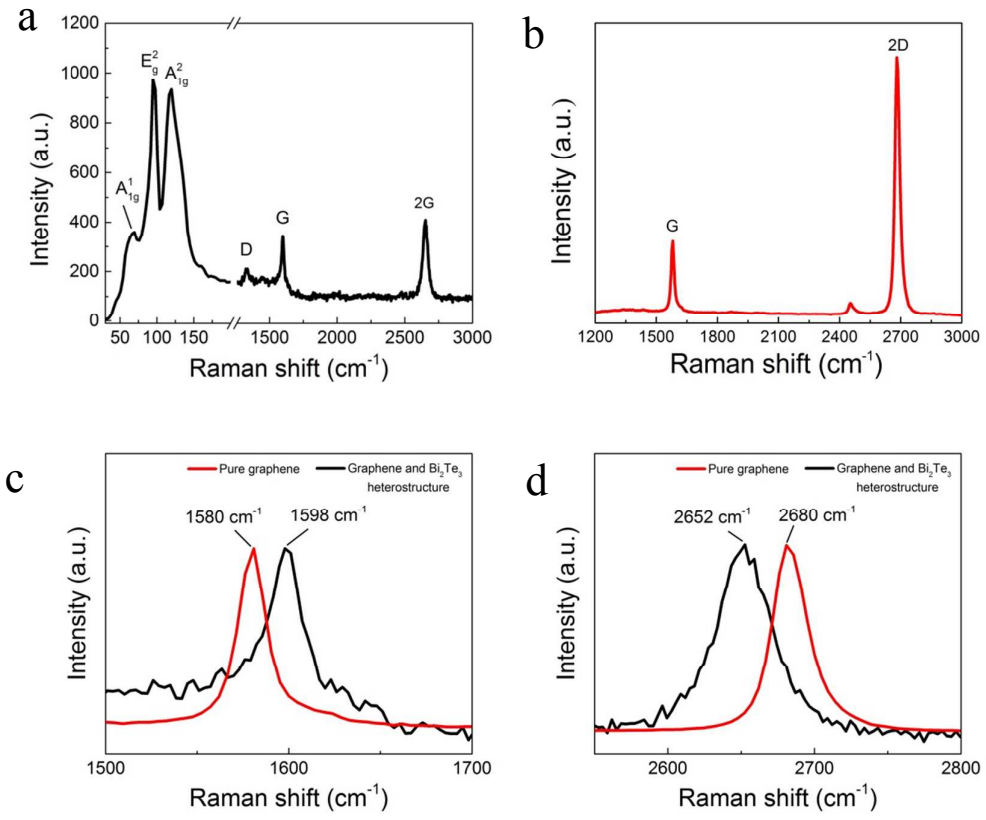

Figure S1 a) Raman spectrum of the graphene-Bi_2Te_3 heterostructure. b) Raman spectrum of the pure graphene. c) Raman G peaks of pure graphene and graphene-Bi_2Te_3 heterostructure. d) Raman 2D peaks of pure graphene and graphene-Bi_2Te_3 heterostructure.

2. Pump-probe experiments for graphene-Bi_2Te_3 hetero-structure samples with different Bi_2Te_3 coverage

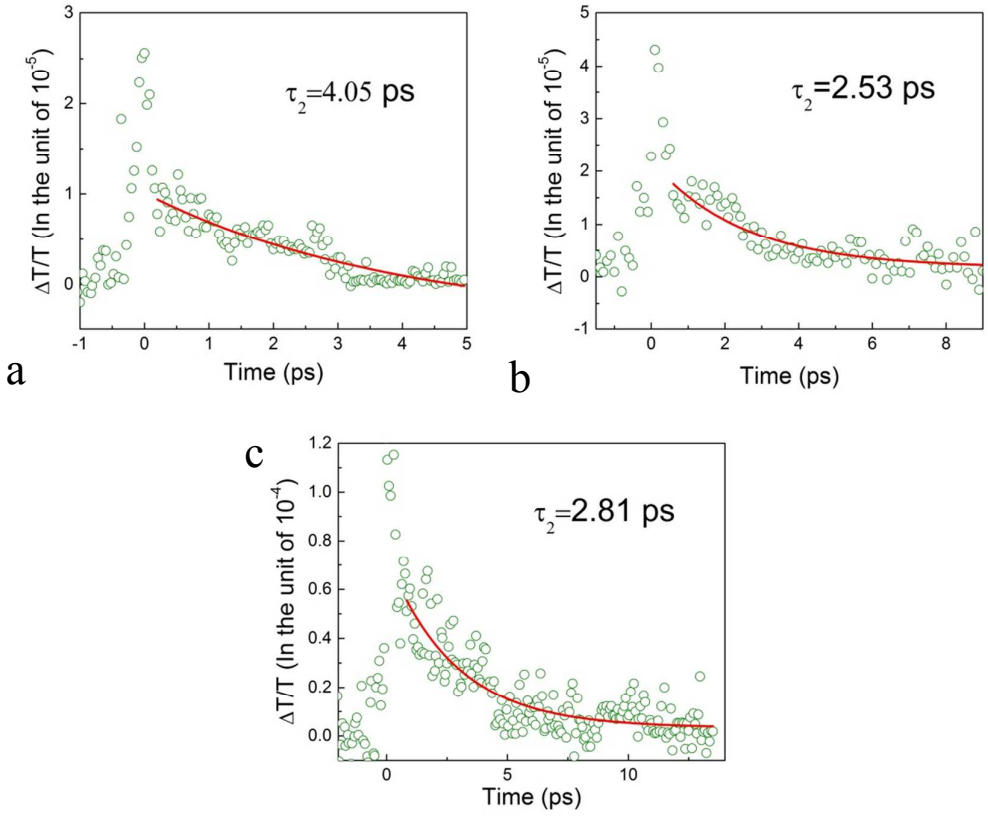

Figure S2 Pump-probe results showing the time for inter-band relaxation in graphene-Bi_2Te_3 heterostructure samples. a) The sample with 15% coverage of Bi_2Te_3. b) The sample with 65% coverage of Bi_2Te_3. c) The sample with 85% coverage of Bi_2Te_3. The samples were pumped and probed at the wavelength of 1550 nm. The open green dots are experimental data and the red curves are analytical fit to the data using exponentials with a time constant τ_2.

We suggested that the second decay times were not very precisely resolved due to the limitation of sampling process in pump-probe measurements. In our pump-probe experiments, we collected data points in equal intervals of time and every sampling point needs an integral time. It is very time-consuming to obtain the same scale of standard error as that of fast decay time (τ_1) as the second decay time has

tens-times time range. We found that the stand errors of the second decay time of all these three samples are relatively high. The second decay times (τ_2) of 15%, 65% and 85% coverage samples are 4.05±1.18 ps, 2.52±0.48 ps and 2.81±0.3 ps, respectively which are all in the picosecond-level, slower than that of graphene but much faster than that of Bi_2Te_3.

3. The experimental setup of the Erbium-doped fiber laser ring cavity.

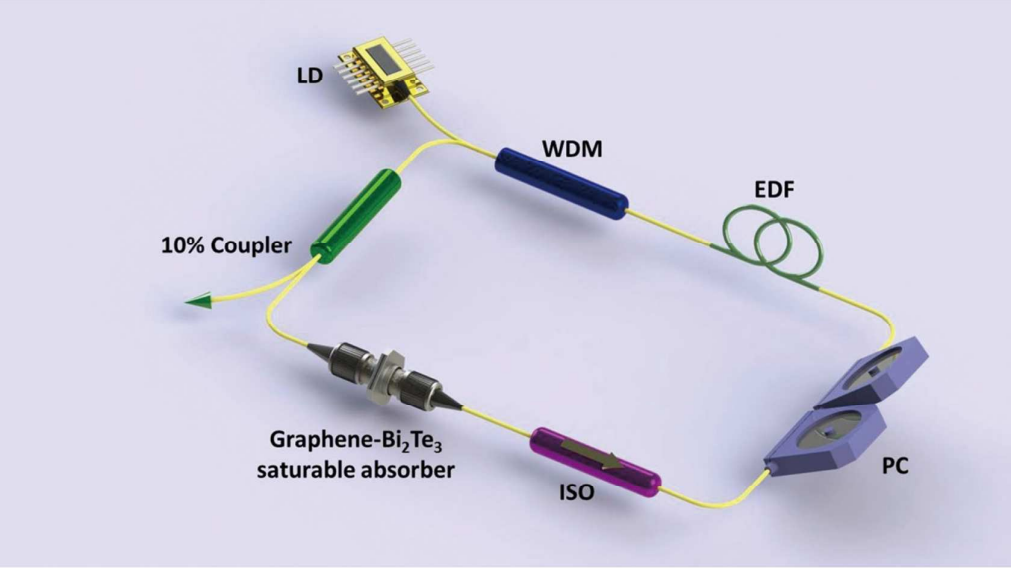

Figure S3. Experimental setup of the Erbium-doped fiber laser ring cavity. LD: Laser diode with work wavelength of 975 nm. WDM: Wavelength division multiplex. EDF: Erbium-doped fiber. PC: Polarization controller. ISO: Polarization independent isolator.

Reference

1. Ni, Z. H.; Yu, T.; Lu, Y. H.; Wang, Y. Y.; Feng, Y. P.; Shen, Z. X., Uniaxial Strain on Graphene: Raman Spectroscopy Study and Band-Gap Opening. *ACS Nano* **2008**, 2, 2301-2305.
2. Ferrari, A. C.; Basko, D. M., Raman spectroscopy as a versatile tool for studying the properties of graphene. *Nat. Nanotechnol.* **2013**, 8, 235-246.