Energy Transport in Bi-Te-Se Topological Insulators

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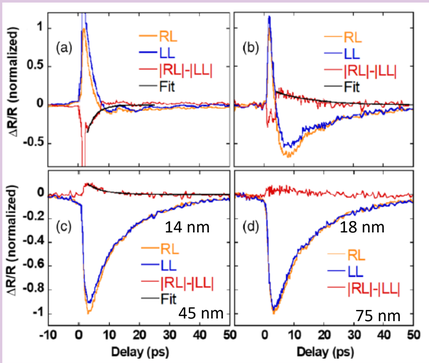
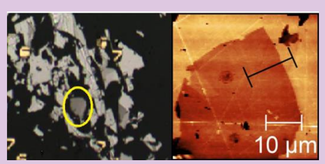
Topological insulators (TIs) are a new phase of material that allows metallic conducting electrons at its surface while the bulk is insulating. Besides, the topological surface electrons' spin orientation is always locked perpendicular to its moving direction, called spin-momentum locking. Our lab studies the intriguing energy transport and dynamics of TIs using optical methods.

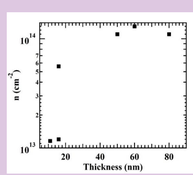
We found the surface states electrons can carry 10+ times of heat than same amount of free electrons. Topological surface electrons can be optical selected by their spin (shown by pump-probe experiment) and thus the gross motion can also be controlled by polarized light (shown by photocurrent experiment).

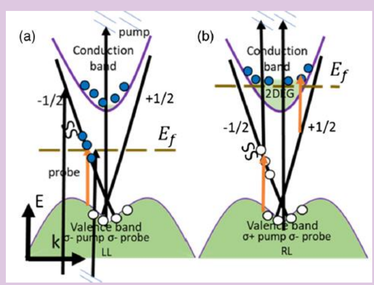


800 nm pump - 7μm probe



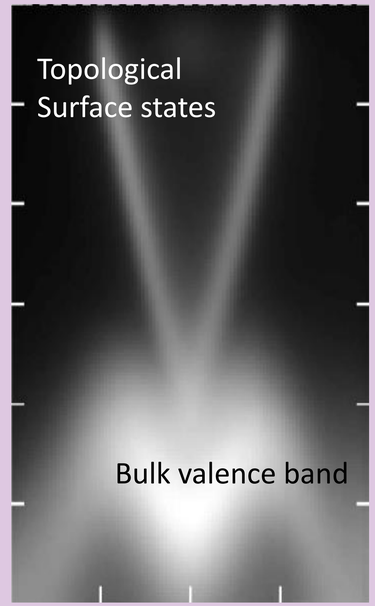
14 nm





Thin samples Thick samples

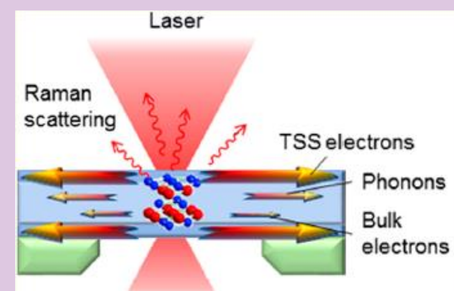
Femtosecond infrared pump probe experiments were performed to study spin-lifetime and relaxation of charge carriers in few layer samples of BTS221

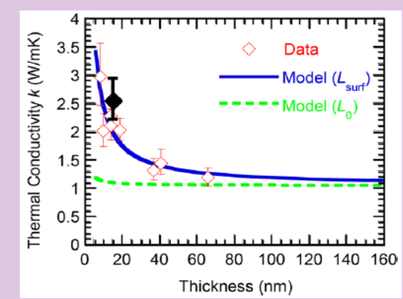


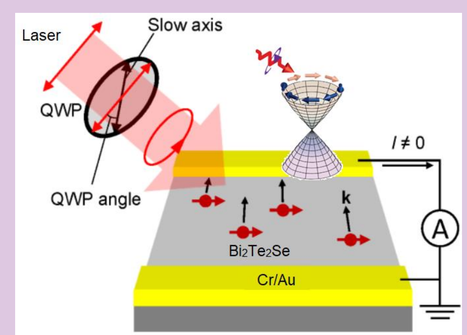
Surface electrons can be controlled by helical light. Photocurrent is enhanced/ suppressed by left/right hand circularly polarized laser incident across the channel, indicating spin-momentum-locked surface electrons selected by ±1 spin of photons.

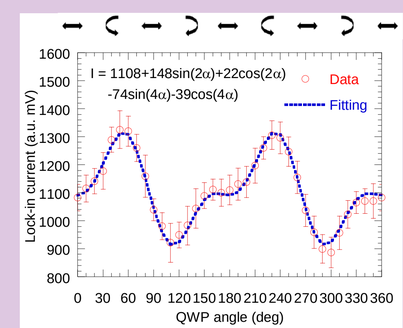
Thermal transport of Bi_2Te_2Se thin films studied by Raman thermometry. Thickness dependence reveals surface state contribution of 50%+ in sub-20-um Bi_2Te_2Se thin films

Surface state electrons carriers 10+ times more heat than ordinary electrons, defined by Lorenz number ($\frac{k_e}{\sigma} = LT$, electrical/thermal conductivity ratio at certain temperature), L_{surf} = 4.4 × 10^{-7} V^2/K^2, comparing to Sommerfeld value L_0 = 2.44 × 10^{-8} V^2/K^2, theoretical value for free electron gas (e.g. in metals)









[1] V. Iyer, Y. P. Chen, and X. Xu, Phys. Rev. Lett. **121**, 026807 (2018).
[2] Z. Luo et al. ACS Nano, **12** (2), pp 1120–1127 (2018)