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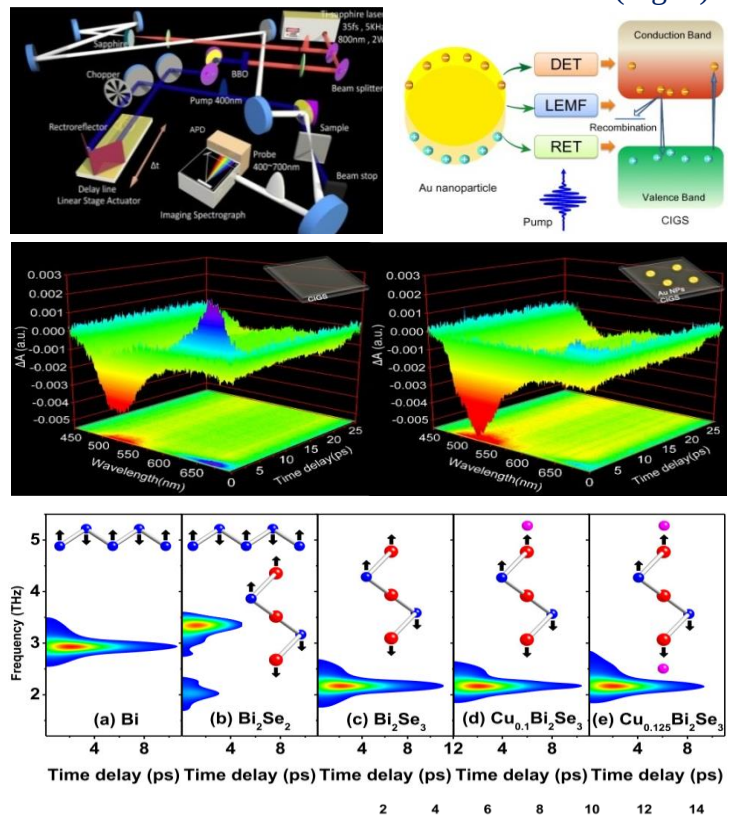
time resolved ultrafast laser spectroscopy, graphene, topological insulators, superconductors, multiferroics, solar cell thin films, pulsed laser deposition and material processing, laser physics and engineering

We study the ultrafast dynamics of superconductor, multiferroics materials, graphene, topological insulators and solar cell thin films by using the ultrafast techniques. Besides, we also prepare the samples by ns and fs pulsed laser deposition and study the changes of physical properties and transfer efficiency after ultrafast laser annealing and patterning. The ultrafast laser systems used include time-resolved pump-probe systems (NOPA, OPOP, OPMP) (Fig. 1), THz time domain spectroscopy (THz-TDS) system, and pulsed laser deposition, annealing and patterning systems.

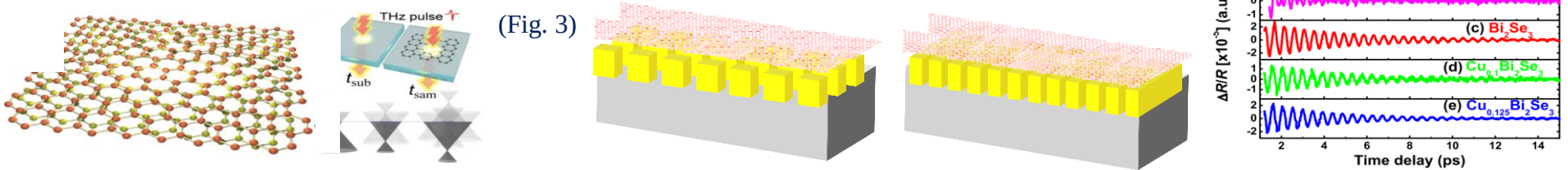
(Fig. 1)




We use the OPOP and OPMP measurements to study the carrier and phonon dynamics, carrier combination, the mechanism of the coherent phonon, and the electronic band structure of graphene and topological insulators with various dopant atoms (Fig. 2). A THz-TDS system is used to study the THz characteristics of these materials, such as complex refractive index, optical conductivity, dielectric constant, chemical potential, carrier scattering rate and mobility (Fig. 3). The study of the ultrafast dynamics of these novel quantum matters by the ultrafast techniques will help us to understand the fundamental physical properties, especially the effect of various dopings on the carrier, phonon, and optical conductivity dynamics near Dirac point, and to develop the potentially revolutionary applications for high-speed/high-frequency/high-efficiency electronic and optoelectronic devices, terahertz –based devices, magneto-electric coupling devices, quantum spintronic devices and nonlinear optical elements.

We also investigate the ultrafast carrier dynamics of CIGS solar cell thin films by using ultrafast laser techniques. The ultrabroardband pump-probe measurement is used to study the ultrafast carrier dynamics, include carrier cooling process, carrier recombination, defect-analysis, and surface plasmonic energy transfer mechanisms (Fig. 1). We expect to obtain important physical parameters from the carrier dynamics in fs and ps timescales, and find the solution to break through the bottleneck of the development of these materials.

(Fig. 2)




(Fig. 3)