

Manipulating Strong Light-Matter Interactions In Graphene and 2D Semiconductors

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We exploit strong light matter interaction in graphene for graphene based optoelectronic devices. We use both scanning photocurrent microscopy and optical pump terahertz (THz) probe spectroscopy to reveal hot carrier behavior in graphene. This hot carrier behavior is crucial to understand the effect of optical excitation on graphene and can potentially lead to efficient solar energy conversion and ultrafast optoelectronic devices. We also exploit the strong light matter interaction in THz regime to make graphene based THz modulator.

Transitional metal dichalcogenide (TMD) is a new class of 2D semiconductors which become direct bandgap semiconductor at a single layer limit. MX_2 exhibits intriguing excitonic physics as well as strong absorption. We combine optical spectroscopy and scanning tunneling microscopy to determine the extraordinarily large exciton binding energy of MoSe_2 . This giant exciton binding energy presents a challenge for efficient carrier separation in solar cell applications. We demonstrate that, by using MoS_2/WS_2 heterostructure, we can achieve a type-II band alignment and realize extremely fast carrier separation.

Sufei Shi is currently an Assistant Professor of the Department of Chemical and Biological Engineering at Rensselaer Polytechnic Institute. Dr. Shi was a Postdoc fellow at the Physics Department of UC Berkeley, working on optical spectroscopy study of two-dimensional (2D) materials. He obtained his Ph.D. degree under the guidance of Prof. Dan Ralph at Cornell Univ. in Jan, 2012. His Ph.D. research was focused on spatially-resolved and time-resolved scanning photocurrent microscopy on graphene based devices, fabrication of metal nano-contact and single electron transistor devices, as well as electrical transport measurement of these devices at ~ 10 mK and high magnetic field. Dr. Shi is currently working on optical spectroscopy of 2D materials, with a particular focus on terahertz (THz) spectroscopy.

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