Understanding 2D Nanosystems using ultrafast time - resolved spectroscopies

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The discovery of graphene has prompted an unprecedented interest in other two dimensional nanomaterials such as layered transition metal dichalcogenides (MoS_2, $MoSe_2$, $MoTe_2$, WS_2,…..), phosphorene and graphane. This talk will focus on understanding the rich physics of these nano systems and their devices using ultrafast time resolved spectroscopies in the visible as well as in TH range. We will discuss our recent experiments on the 2D nanosystems to understand photoexceted nonequillibrium carrier dynamics[1,2]. We show that optical pump induced photo-conductivity of graphene in the terahertz range can be either positive or negative depending on the Fermi energy and the carrier momentum relaxation time. The dominant processes contributing to the photo-conductivity are intraband scattering and secondary hot carrier generation due to Coulomb interaction of photo-excited carriers with the existing carriers in the Dirac cone. The cooling of photo-excited carriers is explained in terms of super-collision model. We will present our very recent results on a few layer MoS_2[3]. The dynamics is shown to be governed by the Auger processes as expected due to the unscreened Coulomb interactions in 2D systems.

[1] Srabani Kar, D.R. Mohapatra, Eric Freysz and **A.K. Sood**, Tuning photoinduced terahertz conductivity in monolayer graphene: Optical pump terahertz probe spectroscopy, **Phys. Rev. B 90,** 165420 (2014).

[2] Srabani Kar, Jayanthi Swetha, Eric Freysz and **A.K. Sood**, Time-resolved spectroscopy of low frequency electronic resonances and optical pump induced terahertz photoconductivity in reduced graphene oxide membrane, **Carbon 80,** 762 (2014).

[3] S. Kar, Yang Su, Rahul Nair, **A.K.Sood**, Probing photoexcited carriers in MoS_2 laminate by time resolved optical pump terahertz probe spectroscopy. **ACS Nano** (2015)