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# Interplay of charge and energy transfer in optically excited van der Waals Interfaces

Optically excited van der Waals heterostructures form a versatile platform to investigate transfer of charge and energy at sub-nanometer length scales. Of particular interest is the heterostructure of graphene and atomically thin layers of transition metal dichalcogenides (TMDC), such as $MoS_2$, $WSe_2$, etc, where the transfer of charge to graphene following dissociation of excitons in the TMDC layer leads to highly sensitive photodetectors due to large optical gain [1-3]. While several reports with optoelectronic transport and reflectance spectroscopy confirm transfer of charge at graphene/TMDC interfaces, recent experiments with Raman and photoluminescence spectroscopy suggest possibility of energy transfer, especially via Forster-type dipolar fluctuations. This talk address this dichotomy with specially prepared van der Waals heterostructure that can distinguish between charge and energy transport when subjected to optical excitation. It will be shown that the transfer of energy can be maximized in heterostructures of graphene and other atomically thin semiconductors with a charge blocking later at the interface. The photoresponse in these structures is governed by hot electron thermalization and intrinsically bolometric in nature [4-5]. We observed exceptional photoresponsivity at high operating speed, even in the infrared regime, that can be of significant interest to new optoelectronic designs.

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[3] Pradhan *et al.* "Ultra-high sensitivity infra-red detection and temperature effects in a graphene – tellurium nanowire binary hybrid", Nanoscale 9, 9294 (2017)
[4] Islam *et al.* "Ultra-sensitive graphene-bismuth telluride nano-wire hybrids for infra-red detection", Nanoscale 11, 1579 (2019)
[5] Ahmed et al. To be published (2019).