

4th International Conference on

Condensed Matter and Materials Physics

August 16-17, 2018 | London, UK



Samit K Ray

S N Bose National Centre for Basic Sciences, India

2D/SI heterostructures for photonic devices

We shall review our recent work on 2D/3D heterostructures for several electronic and photonic devices. The device using GO/Si on illumination shows a broadband (300 nm-1100 nm) spectral response with a characteristic peak at ~700 nm, in agreement with the photoluminescence emission from GO. Very high photo-to-dark current ratio ($>10^5$) is observed upon illumination of UV light. On the other hand, transition metal dichalcogenides (TMDC), an emerging class of two dimensional materials are interesting due to the presence of a finite and direct energy gap in low dimensions, with a wide range of electronic and optical attributes. We have demonstrated the ability to gradually tailoring the optical properties of MoS₂ nanocrystals in terms of PL response and optical absorption, making them attractive for future photonic devices. Chemical doping and plasmonic enhanced photoresponsivity of two dimensional (2D) n-WS₂/p-Si heterojunctions have also been demonstrated. A sharp band-edge absorption of the hybrid material indicates the presence of spin-orbit coupled direct band gap transitions in WS₂ layers, in addition to a broader plasmonic peak attributed to Ag nanoparticles. Stabilized Ag-nanoparticle (~4–6 nm) embedded electron rich n-WS₂ has been used to fabricate plasmon enhanced, silicon compatible heterojunction photodetectors. The detectors exhibited superior properties, possessing a photo-to-dark current ratio of $\sim 10^3$, a very high responsivity (8.0 A W⁻¹) and an EQE of 2000% under 10 V bias. The results provide a new paradigm for intercalant impurity-free metal nanoparticle assisted exfoliation of n-type few-layer WS₂, with the nanoparticles playing a dual role by inducing chemical doping as well as tunable plasmon enhanced absorption.

Recent Publications

1. R K Chowdhury et al. (2017) Synergistic effect of polymer encapsulated silver nanoparticle doped WS₂ sheets for plasmon enhanced 2D/3D heterojunction photodetectors. *Nanoscale*. 9:15591-15597.
2. A Ghorai et al. (2017) Highly luminescent WS₂ quantum dots/Zno heterojunctions for light emitting devices. *ACS Appl. Mater. Interfaces*. 9:558-565.
3. S Mukherjee et al. (2017) Solution processed, hybrid 2D/3D MoS₂/Si heterostructures with superior junction characteristics. *Nanotechnology*. 28(135203):1-11.
4. R K Chowdhury et al. (2016) Novel silicon compatible p-WS₂ 2D/3D heterojunction devices exhibiting broadband photoresponse and superior detectivity. *Nanoscale*. 8(27):13429-13436.
5. S Mukherjee et al. (2016) Novel Colloidal MoS₂ Quantum Dot Heterojunctions on Silicon Platforms for Multifunctional Optoelectronic Devices. *Scientific Reports*. 6:29016.

Biography

Samit K Ray is currently the Director of S N Bose National Centre for Basic Sciences, Kolkata on lien from Indian Institute of Technology, Kharagpur. His research interests are in the area of semiconductor nanostructures, quantum dots, photovoltaics, nanodevices and electronic materials. He has published more than 300 research papers in peer reviewed journals, seven book chapters and co-authored a book on "Strained Silicon Heterostructures: Materials and Devices" published by IEE, UK.

samit@bose.res.in