Dear reader,

I am Samanwita Biswas from West Bengal, India. Currently I am in the final year of my M.Sc. in Physics at Indian Institute of Technology, Ropar. I am working on a project under the supervision of Dr. Mukesh Kumar on "Growth and characterization of $MoTe_2$ for photodetector application".

Graphene as a 2D material has attracted lots of applications in the era of superfast devices. But as a matter of fact it has a zero band gap, which hinders its application in many optoelectronic devices. So here comes the Transition metal dichalcogenides (TMDCs) which show polymorphism, in other words they contain multiple phases. Generally a transition metal is kept sandwiched between two chalcogen atoms (X-M-X) in the form of MX_2 with M being a transition metal from group IV-X (M=Mo, Nb, Re) and X, a chalcogen (X=S,Se, Te). In comparison to other TMDCs $MoTe_2$ offers a wider spectrum in optoelectronic application.

We know availability of wide band gap is appreciable for both fundamental research and application, the direct band gap of TMDCs can be varied with the choice of chalcogen atoms. $MoTe_2$ has a tunable band gap and a low phase transition barrier . It has 1T' and 2H phases and in between there exists an intermediate state of both the phases (which can be used as a heterojunction). 2H MoTe2 shows a direct band gap of ≈1.01 ev, 1T' phase also has a narrow band gap (≈60 mev)with a slight overlap near the Fermi level. Also 1T' yields a carrier density of near about 7.8*10 20 cm-3 and mobility of 4000 cm2 V −1 s −1. And the 2H phase shows a mobility of 40 cm2 V −1 s −1. Basically the 1T' phase is semi metallic and the 2H phase is semiconducting in nature. As of now we have been trying to grow the thin film of $MoTe_2$ in our lab using a sputtering system whereas 'Si' has been used as a substrate.

After growing the thin film we will characterize it with Raman spectroscopy and photoluminescence process. Raman spectra will give different peaks : A^1g mode at ≈173cm $^{-1}$,E^2g mode at ≈235.3cm $^{-1}$ and B^2g mode at≈290.4cm $^{-1}$ The A^1g mode and E^2g mode can be found in bulk crystal whereas B^2g mode can be found in few layered $MoTe_2$,as there is a translation symmetry breaking in single and few layered crystal. We can also use PL as a characterization process. It can be found that $MoTe_2$ in the monolayer limit shows strong PL.1L MoTe 2 are mainly classified into two Type 1 and Type 2 band alignment. The barrier layer with a wide bandgap causes spatial confinement of electrons and holes in the well layer with narrow band gap in a Type 1 band alignment-

this structure can be used in optoelectronics, say in a Photodetector. Now only after a successful confirmation from the characterization process we will try to use the thin film in a photodetector. Also $MoTe_2$ heterostructure can resolve the schottky contact issues in 2D transistors,before deposition of the metal electrode in fabrication of 2H MoTe2 transistor 1T' phase can be patterned only near the area where metal electrodes will be located.

So after going through the project topic I found the project "Novel materials for Quantum optical devices based on layered chalcogenides and their heterostructures closely related to my project work. I do understand that in this superfast industrial area we need continuous upgradation of the devices,so I feel along with my experience of project and interest of doing something I can really do justice to this project (where we have to produce some novel materials which can be used as superconducting photon detector, multiports, parametric amplifier) will give me a greater opportunity for future.

This opportunity excites me a lot as it offers a collaboration between a theoretical and experimental outlook at the project statement, in a way it offers the best of both worlds. It would be the most appropriate choice for my future as I want to become a full time researcher and this field particularly excites me alot. I look forward to a positive response.

Regards,

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