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Nobel Metal Based TMDCs – accessing semiconducting properties of $PtSe_2$ via Liquid Phase Exfoliation.

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In a last decade, transition-metal-dichalcogenides (TMDCs) are receiving a significant attention due to their unique optical and physical properties both in fundamental research as well as potential applications in electronics, optoelectronics, catalysis, sensing etc.
Platinum diselenide ($PtSe_2$), a recent member of TMDCs' group 10, according to DFT calculation undergo a transition from semi-metal to semi-conductor as it gets thinned down to monolayer exhibiting bandgap of 1,2 eV, 0.21 eV and no bandgap for monolayer, bi-layer, and tri- and more layer/bulk respectively. By now only few efforts were taken by the community in order to access predicted monolayer semiconducting properties of $PtSe_2$. Unfortunately, due to the structure resulting in extremally strong interlayer bonding, all only a few- layer $PtSe_2$ were reported to be so far isolated.
Here for the first time, we report successful isolation of bi- and mono-layered $PtSe_2$ nanosheets via Liquid Exfoliation method both in the water-based and solvent-based environment. Nanosheets of a different number of layers were extensively characterized by microscopic and spectroscopic techniques revealing the extremally high quality of LPE $PtSe_2$ while compared to TAC or CVD what is reflected for instance in much narrower Raman Eg^1 and A_1g modes. Moreover, $PtSe_2$ poses exceptional ambient conditions stability and based on first tests exhibits extremally enhanced sensitivity and very short recovery times making it a very promising material to be applied in gas sensing.

References

[1] Backes, Szydlowska, Coleman et all, ACS Nano, 16, 1589-1601, (2016)
[2] Szydlowska, Tywoniuk, Blau, ACS Photonics, 5, 3608-3612, (2018)
[3] O'Brien, McEvoy, Duesberg et all, 2D mater, 3, (2016)

Figures

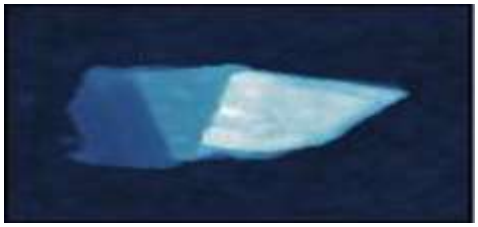

Figure 1: AFM of $PtSe_2$ nanosheet.