Suman Kalyan Pal
Abdus Salam Sarkar, Aamir Mushtaq
Indian Institute of Technology Mandi, Kamand, Mandi-175005, Himachal Pradesh, India

suman@iitmandi.ac.in

Optical Properties of Two-dimensional Tin(II) monosulfide

Two-dimensional (2D) tin(II) monosulfide (SnS) is a member of emerging layered metal monochalcogenide family. The SnS has a 2D structure similar to that of black phosphorus [1]. Theoretical investigations revealed a sizeable band gap, odd-even quantum confinement effect, high carrier mobility and large absorption coefficient in few-layer SnS [2]. The structural anisotropy due to buckled layered structure of SnS could give rise to unique in-plane anisotropic electrical, optical, and mechanical properties. However, the exfoliation of thinner and bigger SnS sheets is still a challenge. We have exfoliated thinner (as thin as bi-layer) 2D SnS of much bigger size (up to few tens of micrometer) through liquid phase exfoliation technique [3]. We have investigated the many-body interactions (exciton-exciton, exciton-phonon etc.) in 2D layered SnS using temperature dependent Raman and time-resolved spectroscopic techniques [3]. Our results reveal that bi-layer SnS exhibits a linear phonon dynamics, while nonlinear behavior is dominant in few-layer SnS. Raman modes of 2D SnS are found to be more sensitivity to temperature than other 2D materials. Ultrathin SnS possesses saturable absorption behavior due to strong nonlinear optical property. The reduced dielectric screening in 2D SnS gives rise to exciton-exciton annihilation (EEA) at low excitation density leading to quick decay of the exciton population. In contrary, at higher excitation intensity, hot exciton is formed via Auger process. Finally, the hot exciton absorbs another (probe) photon of low energy and forms a biexciton. The strong many-body interactions in turn enhance nonlinear optical response of 2D SnS by making them potential candidates for photonic applications.

References

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[2] C. Xin, J. Zheng, Y. Su, S. Li, B. Zhang, Y. Feng, F. Pan J. Phys. Chem. C 120 (2016) 22663-22669.

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Figures

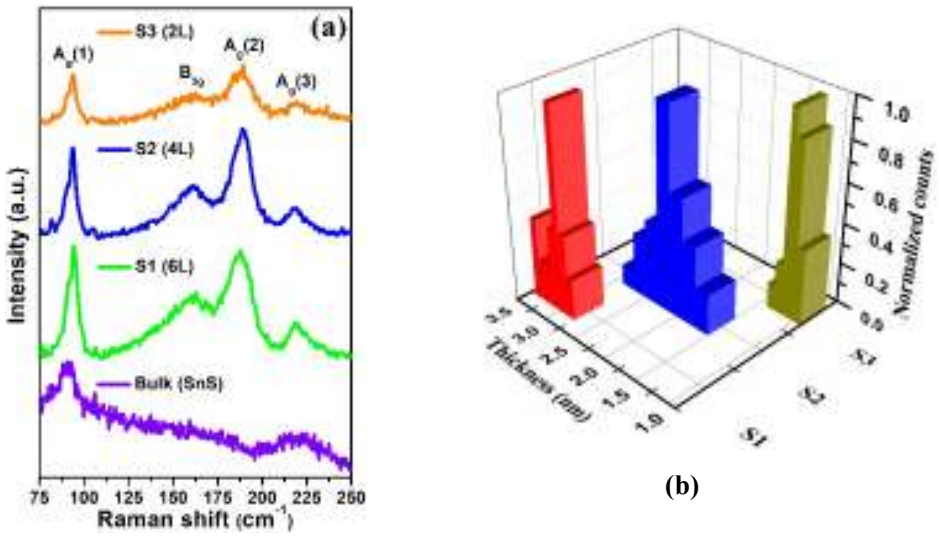

Figure 1: (a) Room temperature Raman spectra of bulk and SnS nanosheets (S1, S2 and S3) of different thickness prepared by LPE. (b) Histograms of thickness distribution of three samples.