Luminescent MoS_2 Quantum Dots Dispersed over Nanosheets- Elucidation of Its Photoluminescence Origin

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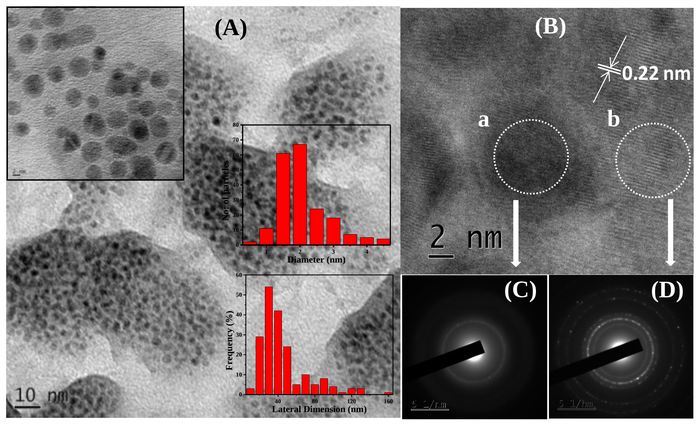
Abstract

- Photoluminescent *MoS_2 QDs interspersed on MoS_2 nanosheets (MoS_2 QDNS)* were synthesized by the hydrothermal reaction of MoS_2 powder and NaOH
- Transmission electron microscopy (TEM), Atomic force microscopy(AFM) and Raman spectroscopic studies reveal the formation of mono and bilayered sheets of MoS_2 along with QDs with size 2- 4 nm
- Emission from three different region (blue, green and near red) are surmised to be arise from smaller QDs, bigger QDs & smaller sheets and bigger sheets, respectively.

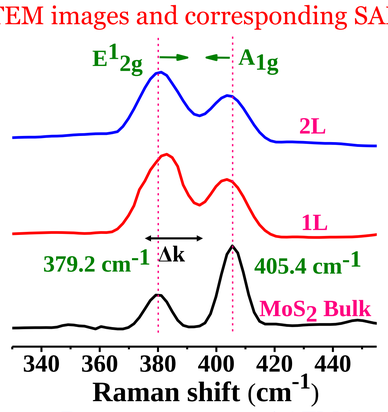
Introduction

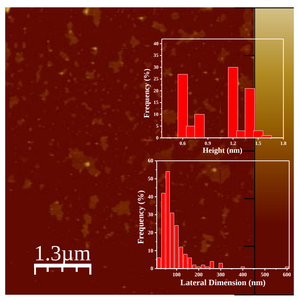
- Transition metal dichalcogenides (TMDs) have been investigated with great attention because of their promising optical, electrical and mechanical properties
- Among TMDs, MoS_2 shows photoluminescence (PL) in quantum dots (QDs) or a few layered nanosheets
- In the present study, highly photoluminescent *MoS_2 QDs dispersed on MoS_2 nanosheets (MoS_2 QDNS)* were synthesized using hydrothermal treatment, which shows excitation dependent emission, that cover a major portion of visible spectra

Characterization

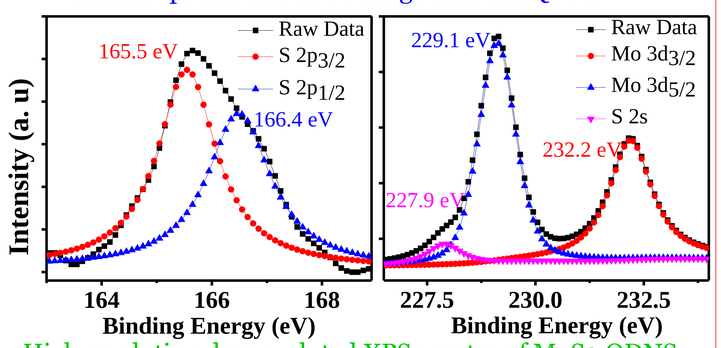


TEM images and corresponding SAED pattern of MoS_2 QDNS



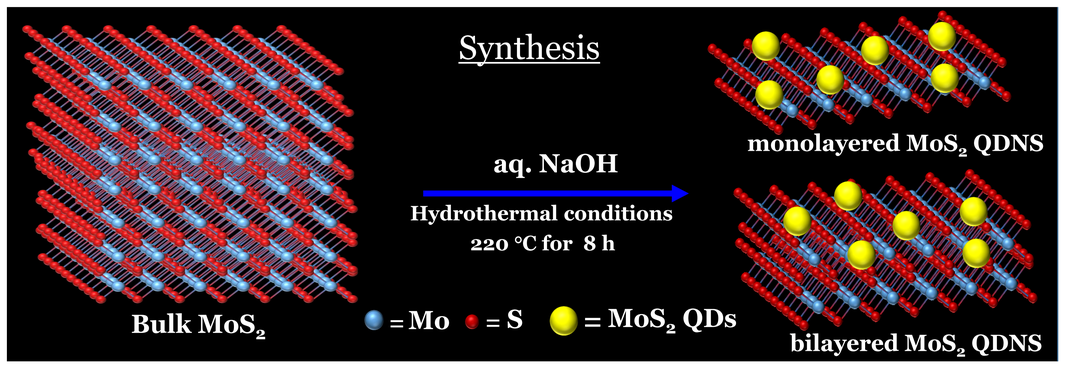


Raman spectra and AFM image of MoS2 QDNS

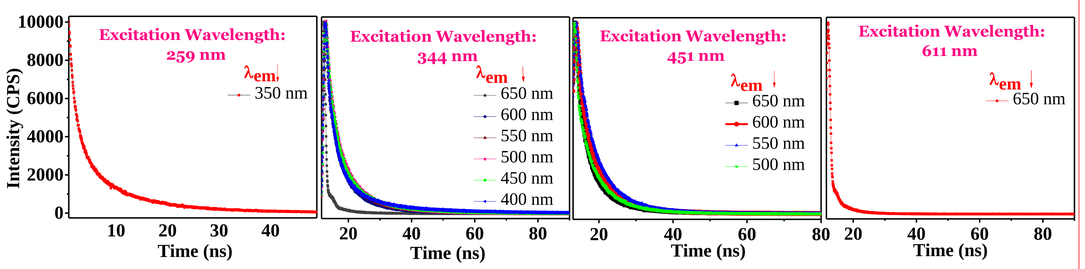


High resolution deconvoluted XPS spectra of MoS2 QDNS

Results and Discussions



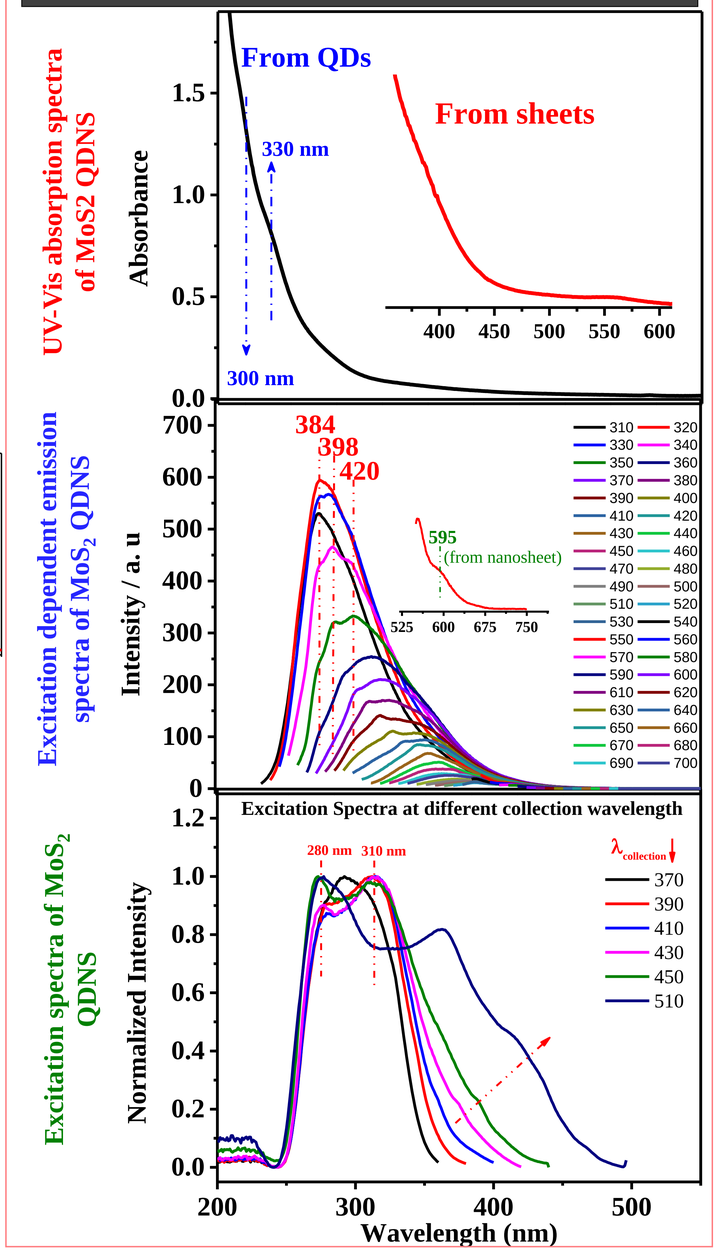
Time Resolved Fluorescence Spectral Studies



λ_{Ex} (nm)	$\lambda_{Collection}$ (nm)	τ_1 (ns)	τ_2 (ns)	τ_3 (ns)
259	350	1.7 (32.10)	7.3 (45.0 %)	19.9 (22.8%)
344	400	0.7 (25.0 %)	4.5 (37.8 %)	19.1 (37.1 %)
	450	0.3 (53.4 %)	2.2 (32.5 %)	15.6 (14.0 %)
	500	0.4 (38.5 %)	2.0 (35.2 %)	13.6 (26.2 %)
	550	0.9 (38.3 %)	5.5 (32.6 %)	12.4 (28.9 %)
	600	0.7 (26.3 %)	4.0 (37.6 %)	10.5(35.6 %)
	650	0.1 (79.8 %)	2.4 (9.5 %)	8.8 (10.6 %)
451	500	1.5 (20.3 %)	4.6 (55.5 %)	10.5 (24.1 %)
	550	1.2 (77.3 %)	---	9.8 (22.6 %)
	600	1.1 (77.0 %)	---	9.6 (22.9 %)
	650	1.1 (78.4 %)	---	7.6 (21.5 %)
611	650	0.1 (79.0 %)	5.0 (20.9 %)	---

Photographs of MoS_2 QDNS

Photophysical Studies



Conclusions

- Uniform and monodisperse QDs of size 2- 4 nm over mono or bilayer of MoS_2 sheets are synthesized from commercially available MoS_2 powder via hydrothermal reaction route
- The MoS_2 QDNS shows high fluorescent emission from blue to near red region
- Thorough photophysical characterization including lifetime studies demonstrated that higher energy emission corresponds to smaller QDs, medium energy emissions stem from bigger dots as well as smaller sheets and lower energy emission orginated from bigger sheets present in the system.

Reference

1. Neema Pallikkarathodi Mani, Manjunatha Ganiga, Jobin Cyriac; *Chemistry Select, 2017,* (Accepted)

Acknowledgements

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