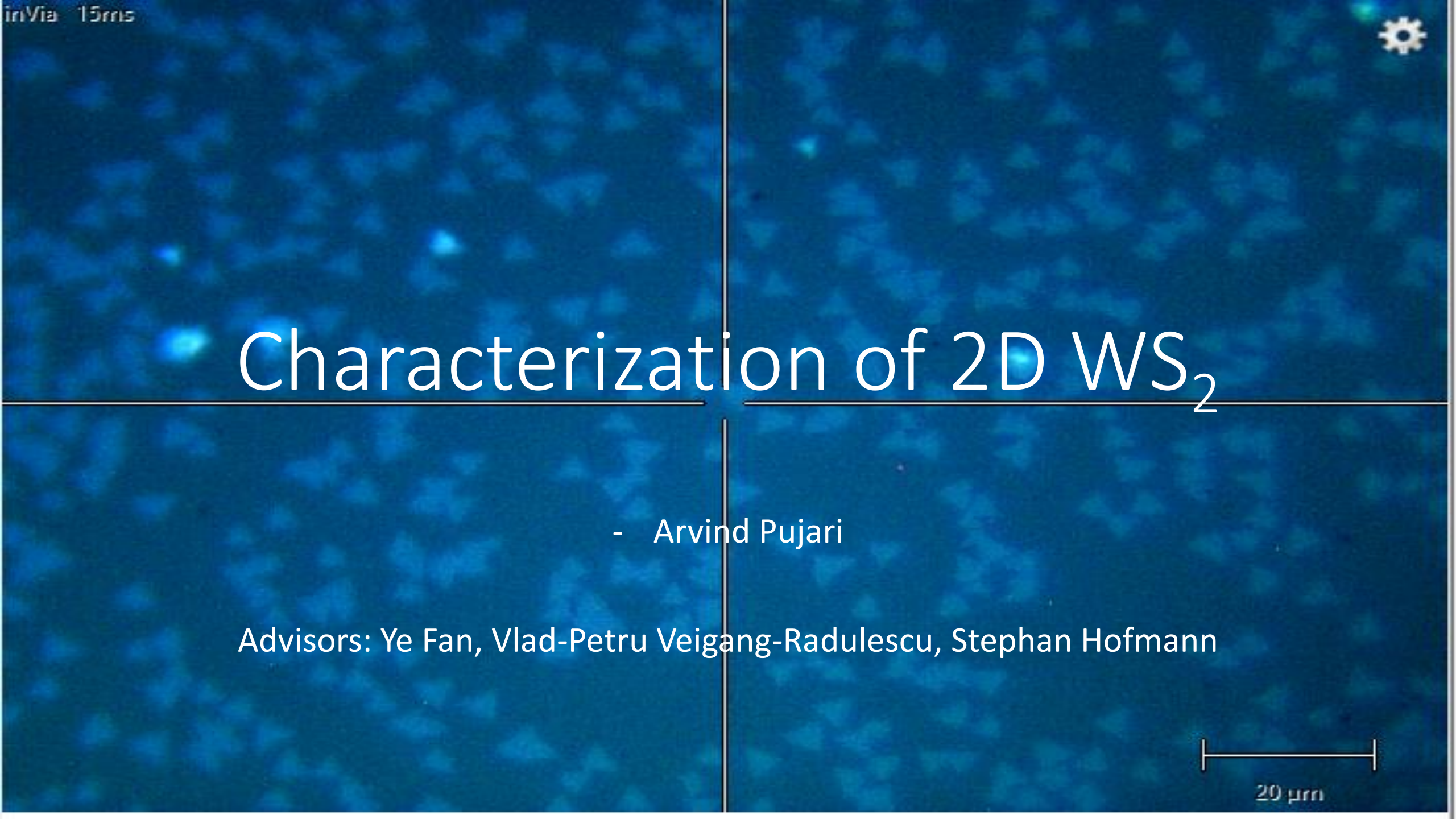
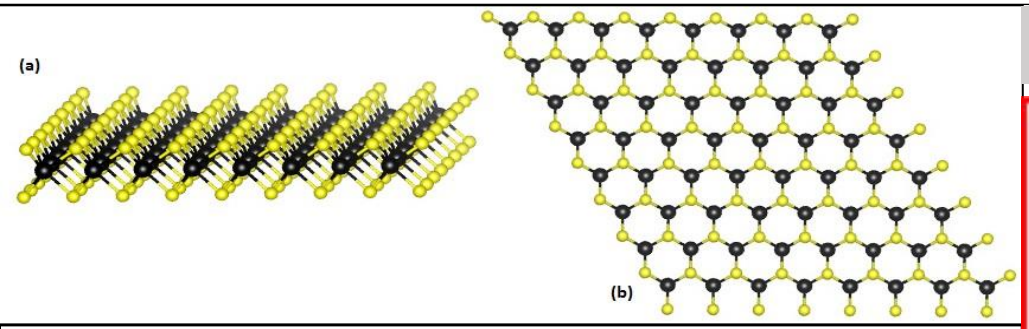


Characterization of 2D WS_2

- Arvind Pujari

Advisors: Ye Fan, Vlad-Petru Veigang-Radulescu, Stephan Hofmann

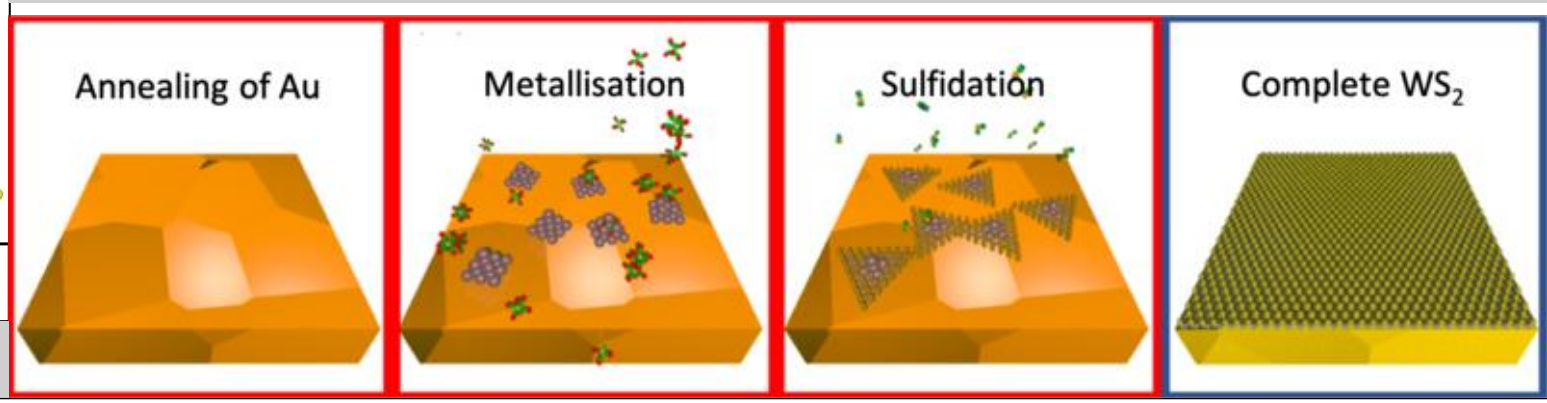
Background



(a) Structure and (b) top view of a WS_2 monolayer

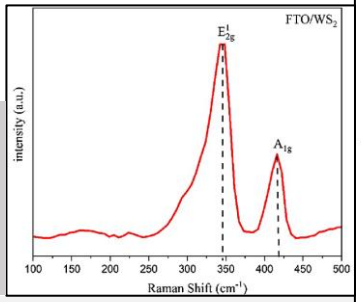
E=2 eV, direct band gap semiconductor

MOCVD Assisted Growth of WS_2



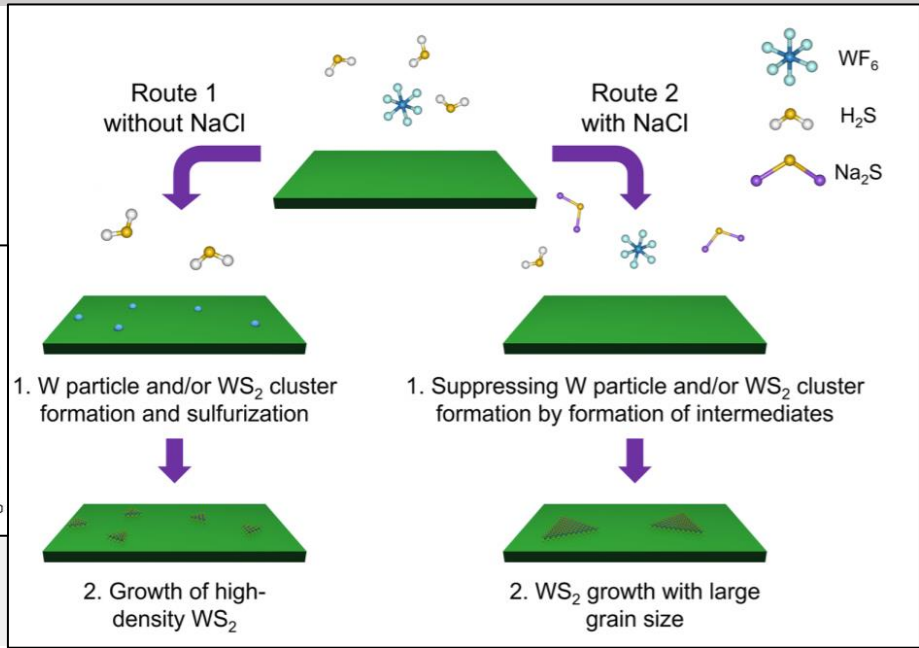
NaCl assisted growth of WS_2

- Drop-casting salt on substrate creates crystallization sites
- Intermediates supress WS_2 cluster formation
- Intermediates enhance wettability of metal precursors and decrease energy for TMD growth



Quality of 2D materials:

- Ratio between E^1_{2g} and A_{1g} peak should be high
- Distance should be about 70 cm^{-1}

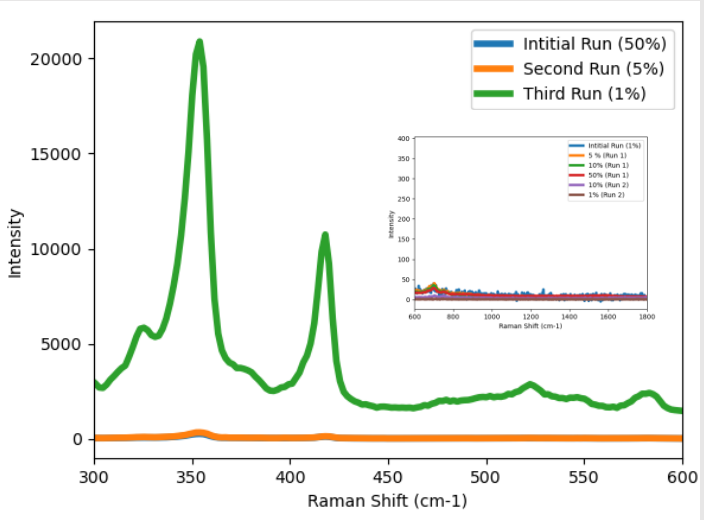


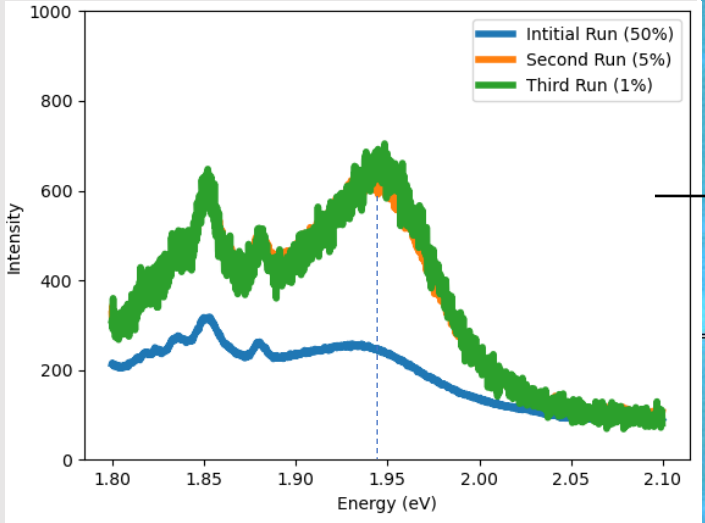
Okada, Mitsuhiro, et al. "Gas-Source CVD Growth of Atomic Layered WS 2 from WF 6 and H 2 S Precursors with High Grain Size Uniformity." Scientific reports 9.1 (2019): 1-10.

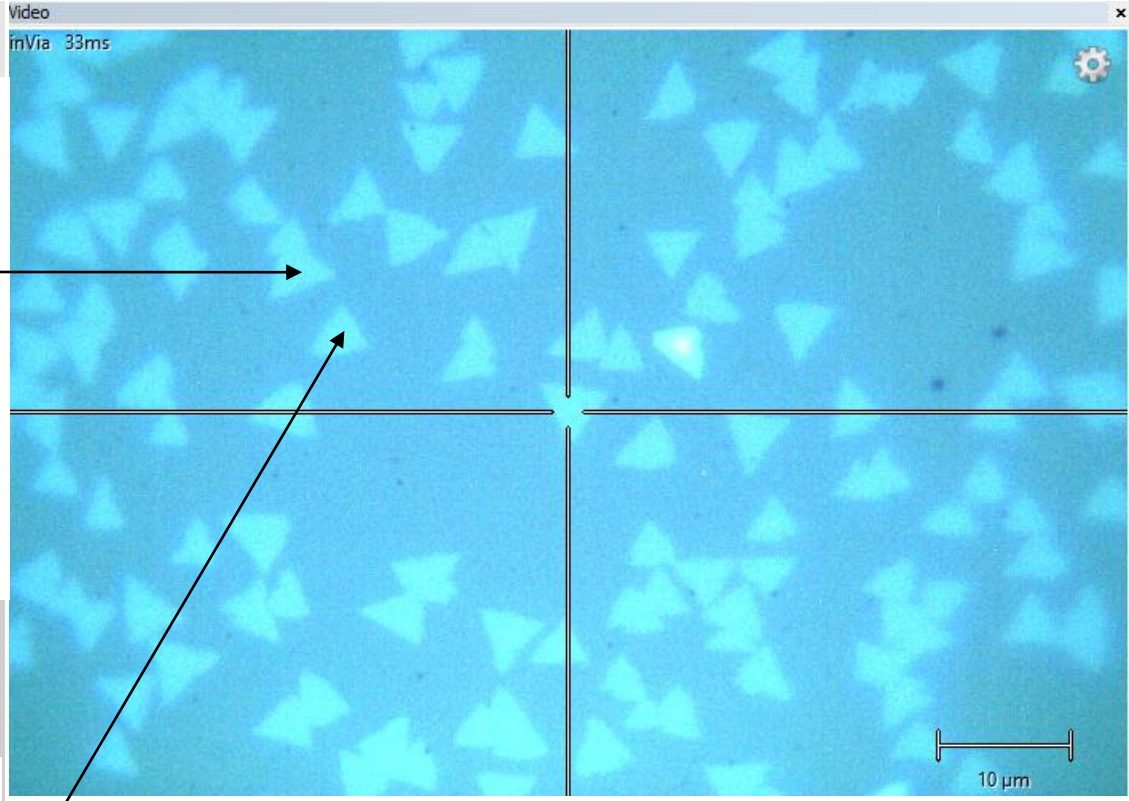
Results

Normalized Spectra

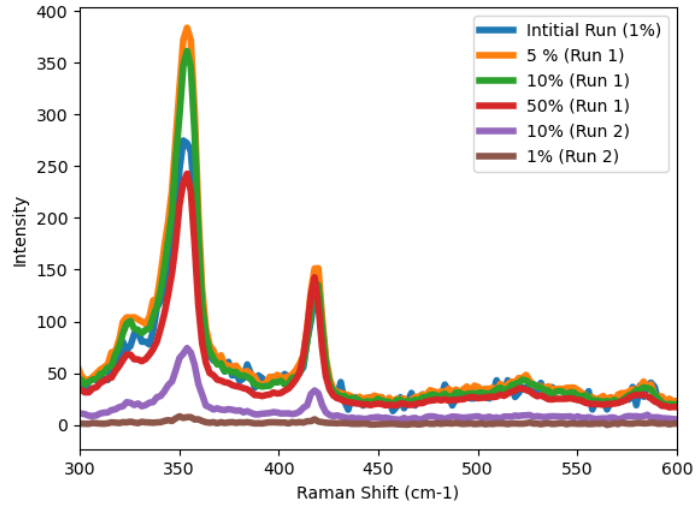
50% power → 5% power → 1% power

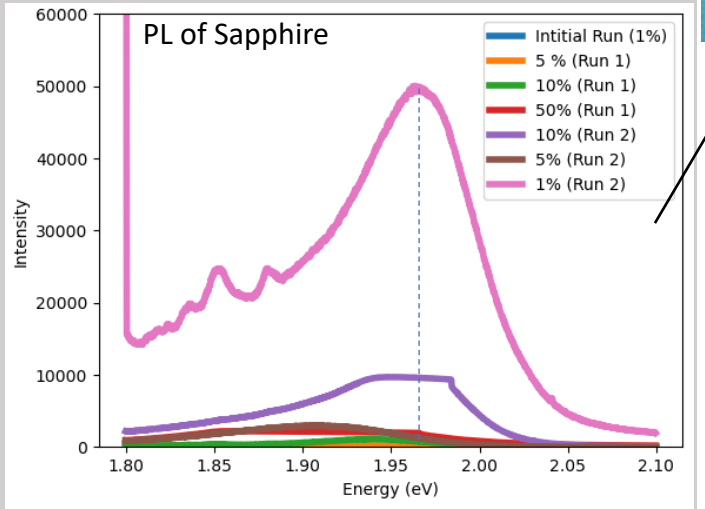






1% power → 5% power → 10% power → 50% power → 10% power → 5% power → 1% power

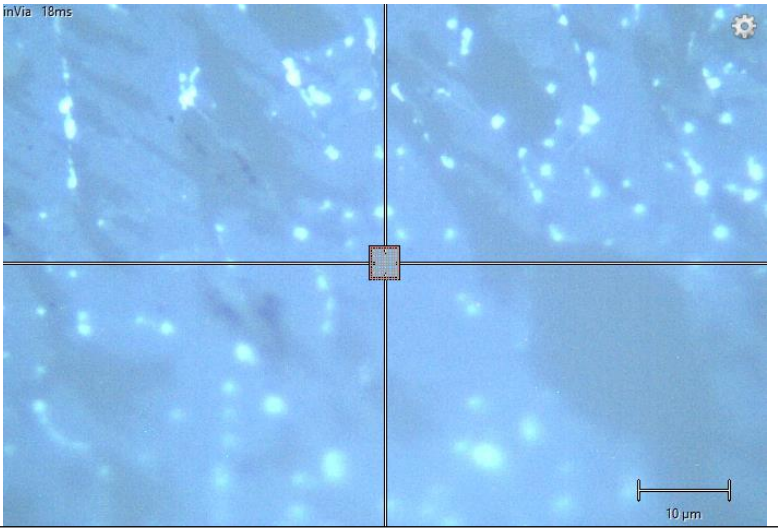




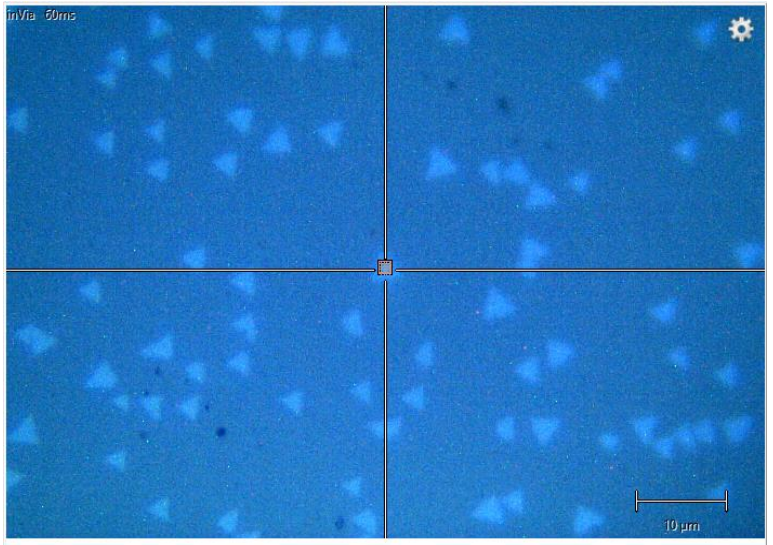
- Photo-annealing effect observed in certain regions of the sample
- Possible causes: defect annealing by laser, amorphous carbon quenching

Map Data

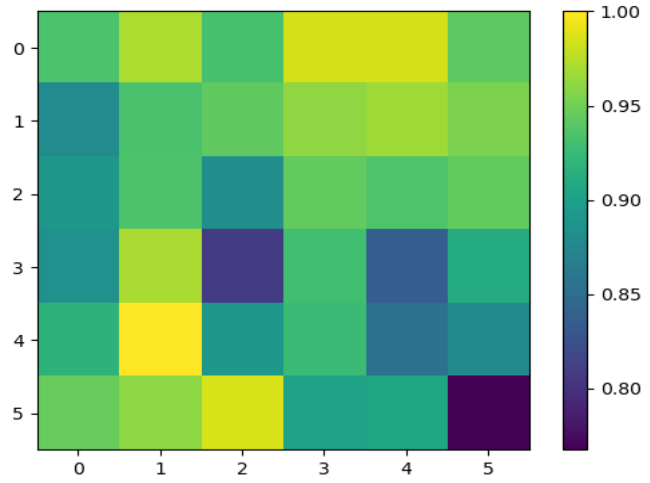
With NaCl

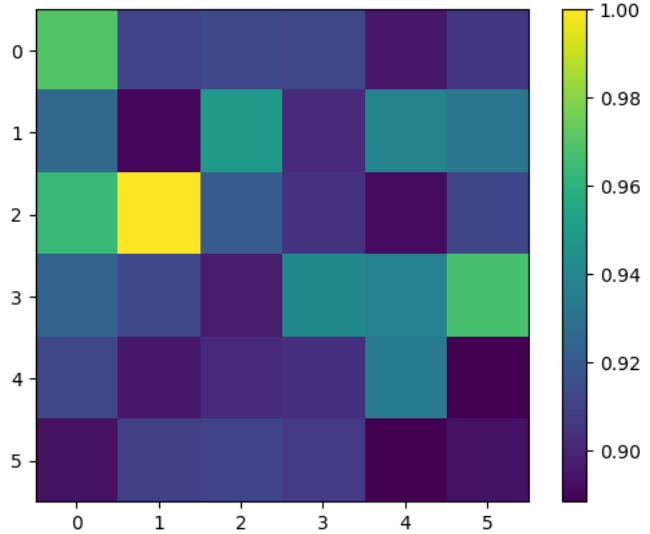


Without NaCl

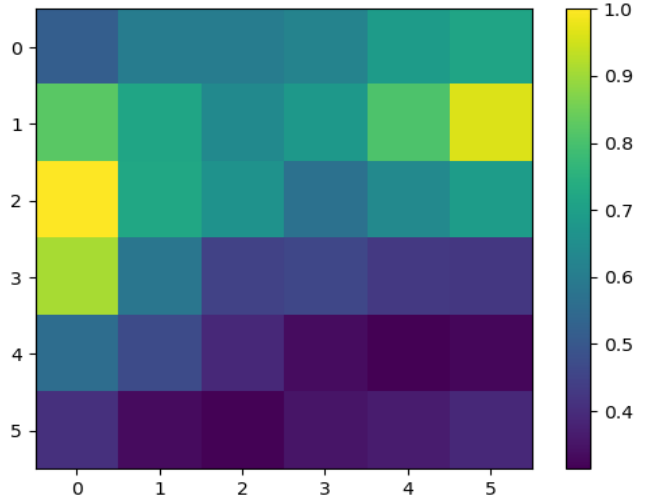


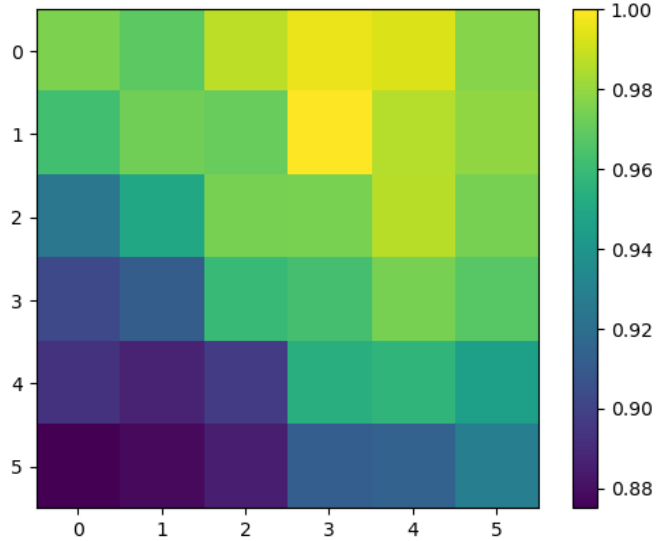
Raman (Peak Ratios)



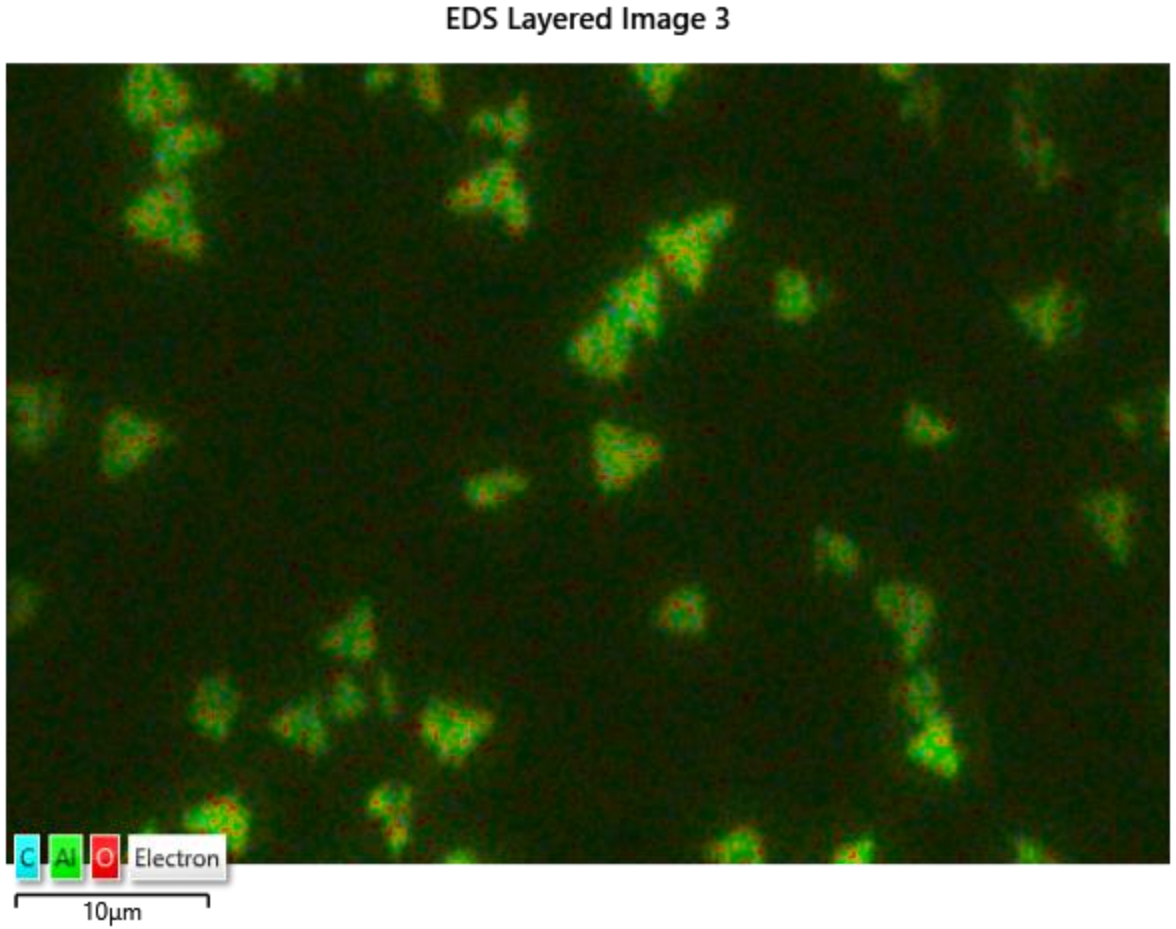


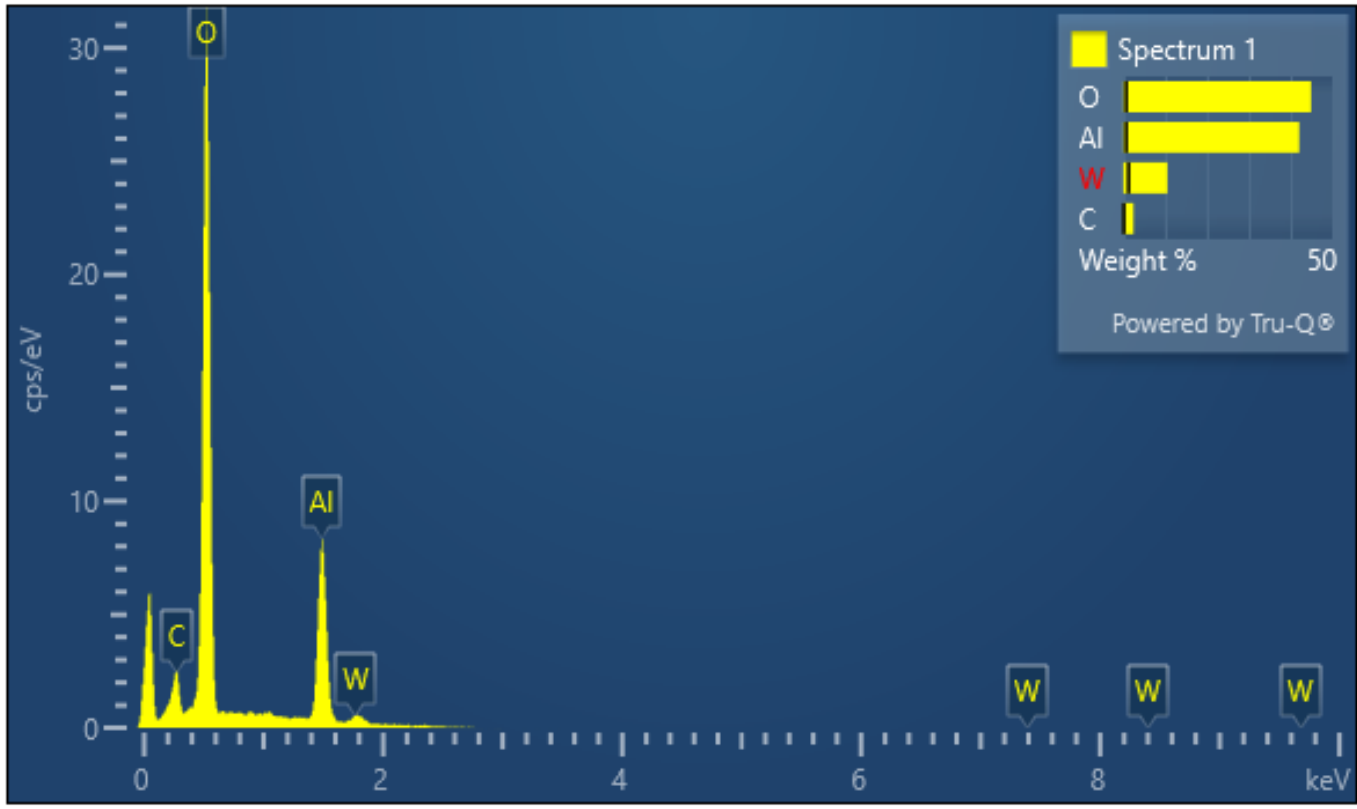
Integrated PL





EDX Data

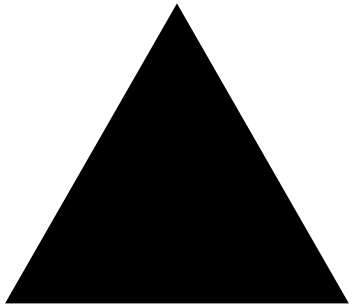




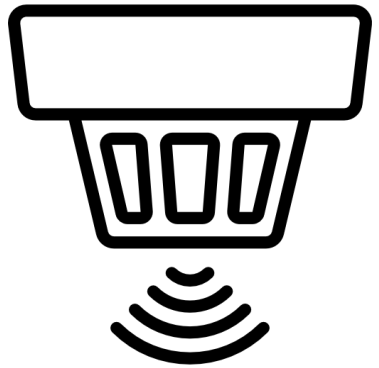
- Expected to see W, Na, Cl, S, Al, O, C
- Small thickness of the sample makes interaction volume very small: not detected by the EDX detectors

Conclusions

Effect of laser quenching on Raman/PL spectra needs to better understood



Non-uniformity across a given domain when NaCl is present needs to be understood



Small interaction volumes make EDX less suitable for obtaining the elemental composition of 2D materials

Future Work:

- Other characterization techniques like XPS may be better suited for this application
- Modelling the effect of the laser beam on these samples (heating effects etc.) may be useful for understanding how the process of measurement changes the sample

Acknowledgements: Ye, Vlad, Eric (EM Suite), Prof. A Tew

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