Project Title: Aerosol assisted chemical vapour deposition (AACVD) of 2D transition metal dichalcogenides for aqueous pollutant degradation

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Project Brief: The aerosol assisted chemical vapour deposition (AACVD) process is summarised in Figure 1.

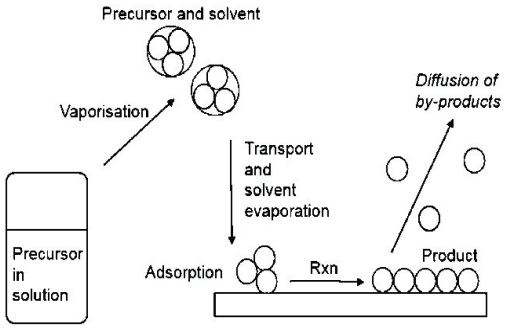

Figure 1: Schematic of the aerosol assisted chemical vapour deposition process.[2]

AACVD has been utilised to produce 2D transition metal disulphides[1] (MoS_2 etc) but to date the 2D transition metal diselenides have proved elusive. Preliminary unpublished data obtained by Dr Worrall in his previous PDRA role suggests that the synthesis is possible (see Figure 2) but more investigations into optimising the aerosol generation need to be performed in order to obtain a high quality material. Parameters to be investigated include the solvent used for production of the aerosol, the concentration of aerosol generated etc. ***Recent successful internal funding bids have enabled the purchase of all the equipment necessary to set up the AACVD synthesis apparatus as well as the characterisation equipment necessary to verify success.***

The treatment of polluted water is becoming increasingly urgent as concerns about water quality become more and more prevalent.[3] As a result catalytic degradation of water borne pollutants is a research area attracting a significant amount of interest, as part of our fight to meet the United Nations Sustainable Development Goal to provide clear water to all.[4] Transition metal diselenides have been investigated as photo catalysts for pollutant degradation and show significant promise.[5]

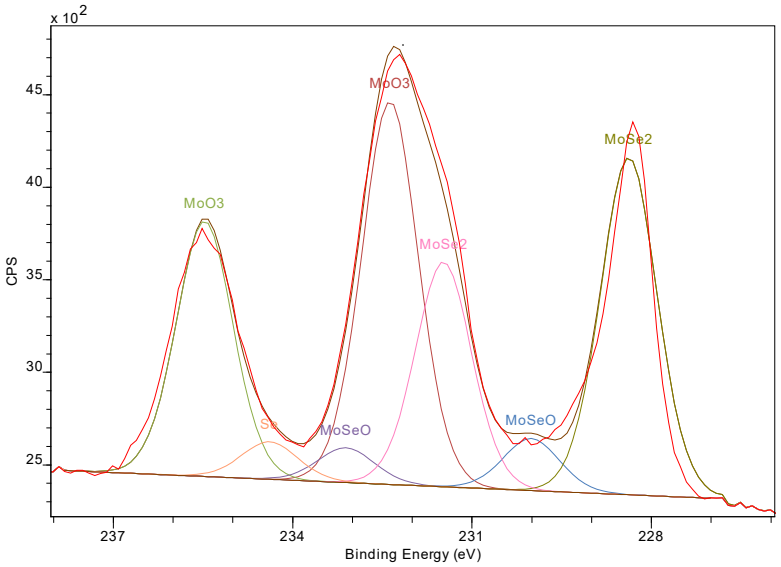

Figure 2: XPS data indicating the formation of $MoSe_2$ via AACVD but also demonstrating the presence of significant amounts of oxides.

The research objectives (**RO**) of this project are to:

RO1 Investigate the aerosol generation parameters in order to successfully use AACVD to synthesise 2D transition metal diselenides for the first time.

RO2 Demonstrate the use of the materials synthesised by the AACVD process in the catalytic degradation of aqueous pollutants.

These RO will lead to both the first confirmed synthesis of transition metal diselenides by AACVD and data on their catalytic performance for waterborne pollutant degradation which will form the basis of a peer reviewed publication.

Selection process and career benefit for student: The excellent candidate student (Saranpreet Singh) has been selected based on ability and knowledge of the subject from excelling on the Nanomaterials module taught by myself and taken by the candidate this year. The student will learn how to generate aerosols and how they can be used for the synthesis of complex 2D nanomaterials. They will also gain invaluable experience of a novel synthetic methodology as well as how to operate/analyse data from advanced analytical techniques Raman, X-ray diffraction and scanning electron microscopy which will be new skills helping them stand out in future job applications. By making decisions on the project direction, with support, and co-authoring the planned publication they will gain full insight into the research process.

References: 1) 10.1021/acs.chemmater.6b05271 2) 10.1039/c5cs00651a 3) WWAP. 2017. The United Nations World Water Development Report 2017: Wastewater, the untapped resource. United Nations World Water Assessment Programme (WWAP). Paris, United Nations Educational, Scientific and Cultural Organization 4) https://sdgs.un.org/goals 5) 10.1039/C8TA02287A