Atomic Layer Deposition of Rhenium Disulfide

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Rhenium disulfide (ReS_2) is a unique material with surprising and attractive properties for ever expanding 2D materials research. In contrast to other transition metal dichalcogenides, ReS_2 has been recently reported[1] to have a direct bandgap even in bulk form as the monolayers are effectively decoupled from each other.

Although mechanical exfoliation is a good method to study the properties of 2D materials, for large scale production and industrial applications it is mandatory to develop reliable 2D materials on large area substrates by vapor phase techniques[2]. Atomic layer deposition (ALD)[3] is an unrivalled method for the deposition of the most advanced and demanding thin film structures. It relies on the alternate supply of precursors and their saturative, self-limiting reactions with the surface species formed by the other precursor. This results in conformal and uniform thin films on large, complex 3D surface areas with simple and precise film thickness control, and good reproducibility.

Here, ReS_2 thin films were grown using ALD for the first time (Figures 1 and 2). The films were deposited on in-situ grown Al_2O_3 using $ReCl_5$ and H_2S precursors at deposition temperatures up to 500 °C. The grown films were characterized using FESEM/EDX, GIXRD, AFM, TEM, XPS, and TOF-ERDA.

References

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[2] M. Bosi, RSC Adv., 5 (2015) 75500
[3] V. Miikkulainen, M. Leskelä, M. Ritala, R. L. Puurunen, J. Appl. Phys., 113 (2013) 021301

Figures

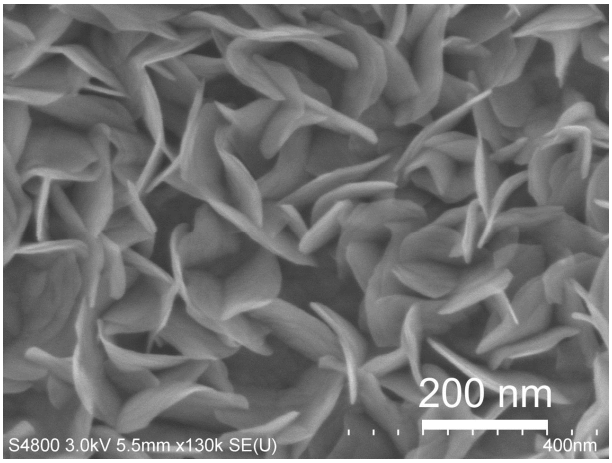

Figure 1: FESEM image of the ALD ReS_2 film.

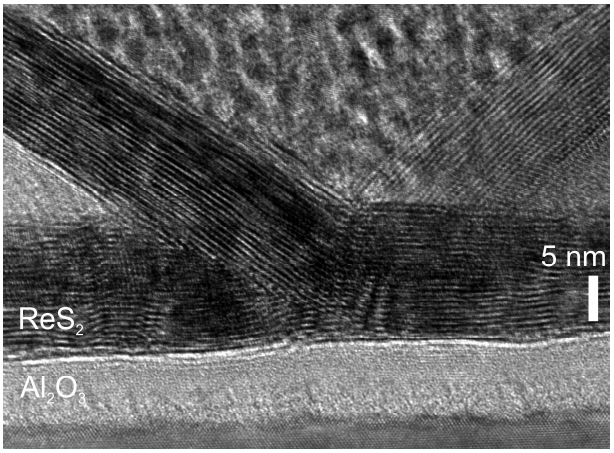

Figure 2: TEM image of the same ALD ReS_2 film.