Growth of Iron selenide layers via salt-assisted chemical vapour deposition

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Abstract

Iron selenide compounds (Fe_xSe_y) are an emerging class of materials known for their remarkable superconducting, catalytic and magnetic properties. It has been established that single-layer tetragonal iron selenide (FeSe) on strontium titanate ($SrTiO_3$) has proven to be an excellent superconductor at a critical temperature of ~55 K [1]. While other stoichiometries can have drastically different properties, for example, Fe_3Se_4 presents metallic features similar to that of other transition metal chalcogenides (TMCs) having an average conductivity of 9.54×10^4 S m^{-1} for thin layers of 8 nm [2]. Other stable stoichiometric compounds exhibit similar properties, for instance $FeSe_2$ and therefore it is clear that Iron selenides have untapped potential for quantum technologies [3]. In this work, we present the epitaxial growth of a range of 2D iron selenide compounds, Fe_xSe_y on silicon dioxide (SiO_2) substrate using a salt-assisted chemical vapour deposition (CVD) method. The iron and selenium ratio can be finely tuned by the weight ratio of precursors selenium and Iron oxide (FeO) powders, and the growth promotor ammonium chloride salt. Furthermore, allowing the growth of various layer thicknesses with triangle and hexagonal morphologies (Figure 1) which have the potential to be scaled up to wafer-scale coverage. The as-grown structures were characterized using X-ray diffraction (XRD), Raman and Energy dispersive X-ray (EDX) techniques (Figure 2), showing clear stochiometric control and chemical stability under ambient conditions. These characterization techniques allow the opportunity to explore the role of the growth-promoting ammonium chloride salt in the synthesis process and how this influences the formation of iron selenides or Iron oxide. The successful growth of 2D iron selenide with different stoichiometry and morphologies offers the prospect of applications in quantum technology.

References

[1] Liu, D., et al., Nature Communications (2012) 931.
[2] Huan, Y., et al., Advanced Materials, 1 (2023) 2207276.
[3] Liu, H., & Xue, Y., Advanced Materials 17 (2021) 2008456.

Figures

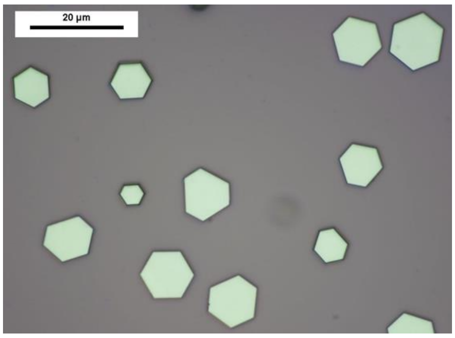

Figure 1: Optical image of Fe_xSe_y grown on SiO_2.

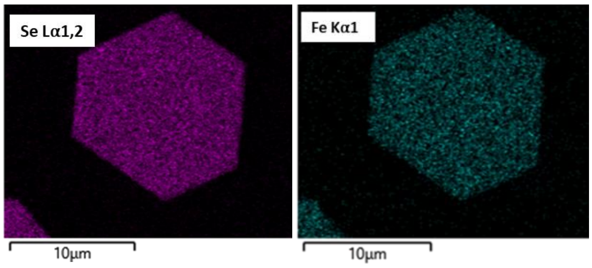

Figure 2: EDX map of FeSe grown on SiO_2.