Growth of van der Waals Magnet $Cr_{(1+\delta)}Te_2$ using a Hybrid Pulsed Laser Deposition Technique

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State-of-the-art thin film deposition techniques, such as pulsed laser deposition (PLD) and molecular beam epitaxy (MBE), are used in materials science engineering to artificially fabricate complex thin film materials. Epitaxial thin films with controlled defects and orientation are interesting for modifying material functionalities like surface-sensitive electrocatalysis, crystal structure-dependent magnetism, and magnetocrystalline anisotropy. We developed a hybrid PLD system attaching molecular beam sources to fabricate oxide, oxynitride, and telluride systems. In this hybrid setup, elements (e.g., S, Se, Te, Zn) with a high vapor pressure at the standard surface temperature (during laser ablation) of a PLD target are supplied through molecular beam sources. Additionally, different gases are provided through an RF microplasma source. This hybrid setup makes a wide range of cation and anion engineering possible in complex materials.

In this presentation, we will address challenges in the growth of thin films and how modifications in the defects and structure influence functional properties by taking the example of van der Waals material $Cr_{(1+\delta)}Te_2$. By varying the number of Cr intercalants (δ), the ferromagnetic T_C and magnetocrystalline anisotropy of this telluride can be modified [1]. Our work observed ferromagnetism and perpendicular magnetic anisotropy in $Cr_{(1+\delta)}Te_2$, with the highest T_C of 324 K in Cr_2Te_3 [2]. Upon adding a Te-rich interfacial layer, the T_C of $CrTe_2$ (155 K) increased to above room temperature (342 K), and the magnetization easy axis was reversed. In addition to the detailed growth and characterization of van der Waals magnet $Cr_{(1+\delta)}Te_2$, we will also discuss how a hybrid PLD deposition system can be utilized to grow high-entropy tellurides.

[1] Y. Fujisawa *et al.*, Physical Review Materials, 4 (2020) 114001, https://doi.org/10.1103/PhysRevMaterials.4.114001

[2] A. Tschesche, *et al.*, Preprint on Research Square (2024), https://doi.org/10.21203/rs.3.rs-4861088/v1