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ABSTRACT:

Structural and Electronic Properties of SbxTey Thin Films: Role of Ge(110) and Ag(110) Substrates

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X2Y3 (X =Sb; Y =Te) are chalcogenide compounds with a narrow gap and a rhombohedral crystalline structure. Their structure consists of atoms covalently bonded within layers that are stacked through van der Waals interactions, forming 5 atom thick layers (Y-X-Y-X-Y), commonly referred to as quintuple layers (QLs) [1]. Owing to these structural and electronic properties, these materials are well known for their thermoelectric performance and for being topological insulators, making them promising candidates for a variety of applications such as quantum computing, mode-locking in laser systems, and cooling technologies.

To exploit these properties in practical devices, it is essential to grow high-quality thin films. The properties of chalcogenide thin films are highly sensitive to the underlying substrate, yet the precise mechanisms governing this dependence remain poorly understood. In this work, we investigate a simplified growth method for Sb2Te3 thin film on Ge(110) and Ag(110) surfaces using a single evaporator cell [2]. The structural and electronic properties of the film are characterized using standard surface science techniques, including (LEED, UPS, XPS, HREELS). Our results reveal how substrate-induced strain, interfacial chemistry, and crystallographic orientation influence their functional performance.

Furthermore, the effect of hydrogen exposure is investigated. Hydrogen is known to influence the electronic and chemical properties of many materials by modifying surface states, passivating defects, or acting as a reducing agent, which can affect the band structure and electrical conductivity. Studies on chalcogenide materials such as MoS_2 [3] have shown that hydrogen adsorption can modify their electronic properties, motivating the investigation of hydrogen (H2, H*, H2*) treatment as a possible way to tune the properties of chalcogenide films.

Overall, the proposed growth method simplifies the deposition process and appears to reduce the number of defects induced during growth, which could be advantageous for future applications. This study provides insights into substrate engineering for tailored SbTe-based devices in thermoelectrics and spintronics.

[1] H. Zhang & al., Nature Physics (2009) 1270
[2] M. Minissale & al., Physica E 160 (2024) 115952
[3] E.W. Keong Koh & al., International Journal of Hydrogen Energy 37 (2012) 14323-14328