Exploring the electric and thermoelectric response of ferroelectric 2H and 3R alpha-In2Se3 based devices

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Two-dimensional (2D) van der Waals (vdW) materials are of great interest due to their unique physical properties and draw significant attention in a variety of fields. Among these materials, vdW 2D ferroelectric (FE) a-In_2Se_3 is widely studied for its ability to show ferroelectric behavior down to the thin layer limit [1], playing an important role in a wide spectrum of semiconductor technologies and device applications. Moreover, a-In2Se3 has recently revealed a highly metallic two-dimensional electron gas (2DEG) at its surface [2]. In this context, the thermoelectric (TE) properties of 2D ferroelectrics and their interplay with its unique physical properties (FE, 2DEG) remain unexplored. Theoretical calculations have shown promising TE efficiency for a-In_2Se_3, including an enhanced Seebeck coefficient [3], and a low thermal conductivity [4]. We have very recently investigated the electric and thermoelectric properties of thin layers (~100 nm) of the 2H and 3R polymorphs of the 2D ferroelectric a-In_2Se_3 embedded in solid-state three-terminal devices (Figure 1) [5]. Charge transport measurements reveal a hysteretic behavior, that can be ascribed to the effect of ferroelectric polarization at the metal electrode/2D semiconductor interfaces. The thermoelectric investigation of the same devices unveils a well-defined negative signal of the order of 100 - 200 µV/K in absolute value for the 2H polymorph, showing a slight modulation as function of the gate voltage. An analogous but noisy thermoelectric voltage is measured for devices based on the 3R polymorph, where indeed a constant finite transversal offset in the 100 µV-few mV range is detected, which does not depend on the applied temperature gradient. We speculate that these experimental observations are related to a strongest residual in-plane ferroelectric polarization in the 3R a-In_2Se_3 polymorph thin layer. Our results show that the thermoelectric response is a fine probe of the ferroelectric character of 2D layered a-In_2Se_3.

References

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Figures

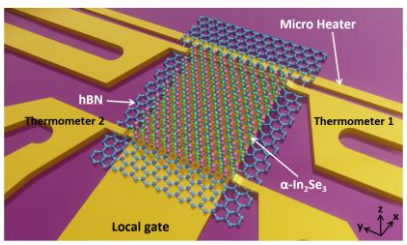

Figure 1: Schematic of the a-In_2Se_3-based 3-terminal device