RESEARCH ARTICLE

Low thermal conductivity and high carrier mobility in type-II Dirac semimetal $PtTe_2$ thin films

Tianran Jiang[1], Huiping Wu[1], Shuxiang Wu[2**], Yanqi Huang[3], Wenjie Li[3], Jing Shuai[3], Ziyu Wang[4], Tianshu Lai[1**], Ke Chen[1**]

[1] Guangdong Provincial Key Laboratory of Magnetoelectric Physics and Devices, State Key Laboratory of Optoelectronic Materials and Technologies, School of Physics, Sun Yat-sen University, Guangzhou 510275, China

[2] School of Materials Science and Engineering, Sun Yat-sen University, Guangzhou 510275, China

[3]School of Materials, Sun Yat-sen University, Shenzhen 518107, China

[4]Key Laboratory of Artificial Micro-structures of Ministry of Education, School of Physics and Technology, Wuhan University, Wuhan 430072, China

Corresponding authors. E-mail: wushx3@mail.sysu.edu.cn, stslts@mail.sysu.edu.cn, chenk35@mail.sysu.edu.cn

Received June 23, 2026; accepted August 12, 2026

Supporting Information

We re-measured the average thickness of the MBE-grown $PtTe_2$ thin film using a SuperView W1 optical 3D profilometer (CHOTEST Technology Inc., Shenzhen, China; vertical resolution: 0.1 nm) based on white-light interferometry. The average thickness measured over a large area of the $PtTe_2$ thin film is approximately 5.3 nm, as presented in **Figure S1a**. The measurement results are consistent with our previous measurements of $PtTe_2$ thickness obtained using cross-sectional scanning transmission electron microscopy (STEM) [1]. Meanwhile, after comparing the obtained XRD characterization data in $PtTe_2$ with the standard PDF card (No. 18-0977), we found that the characteristic diffraction peaks of the hexagonal $PtTe_2$ are largely consistent as shown in **Figure S1b**. This result is consistent with previously reported findings [1, 2].

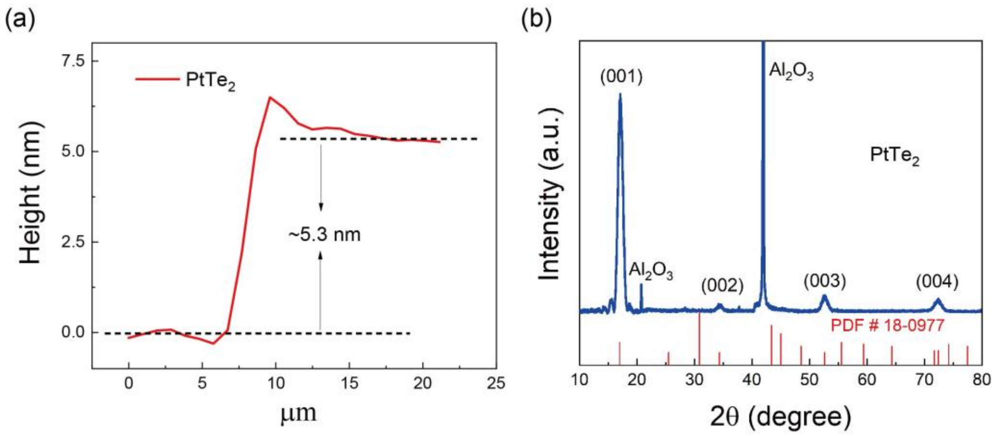

Figure S1. (a) The step height indicates a thickness of 5.3 nm in $PtTe_2$ film. (b) XRD pattern of the $PtTe_2$ thin films epitaxially grown on an Al_2O_3 substrate.

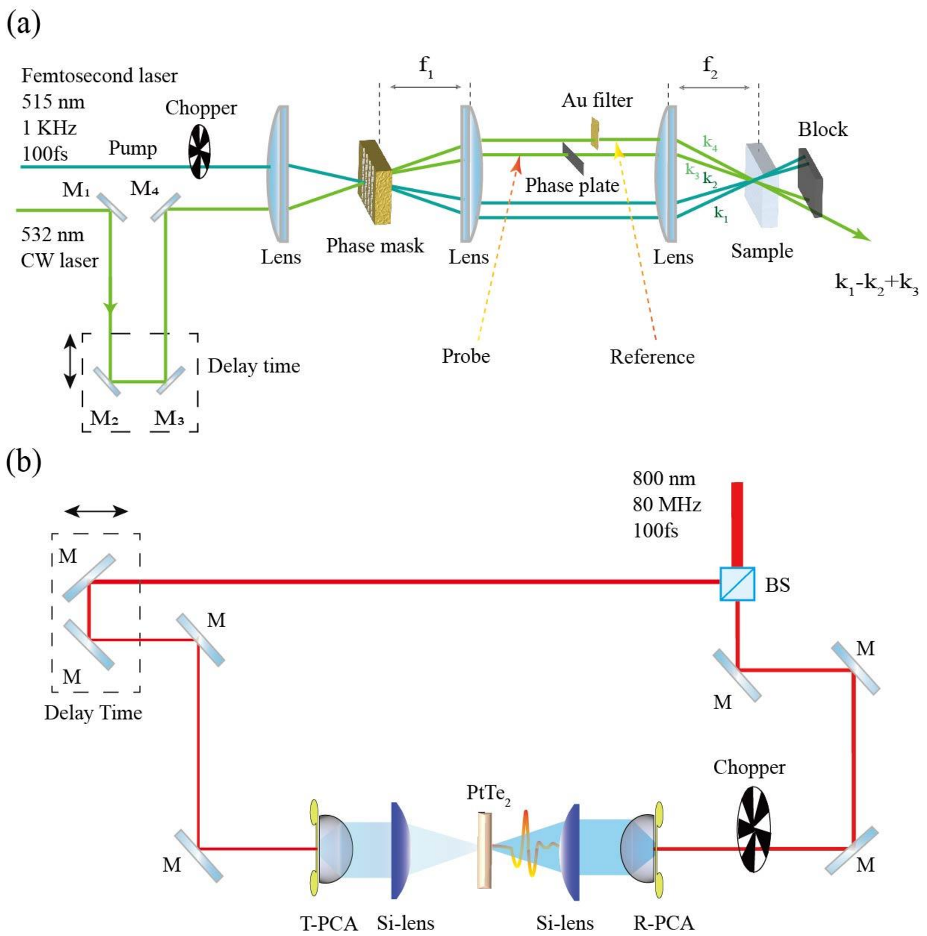

Figure S2. (a) Schematic illustration of a typical transient thermal grating experiment. (b) Schematic diagram of the THz-TDS experimental system based on a low-temperature grown gallium arsenide photoconductive antenna detection.

Conductivity measurements of the epitaxial Dirac semimetal $PtTe_2$ as shown in Figure S3 were performed in a Physical Property Measurement System (Quantum Design, PPMS DynaCool).

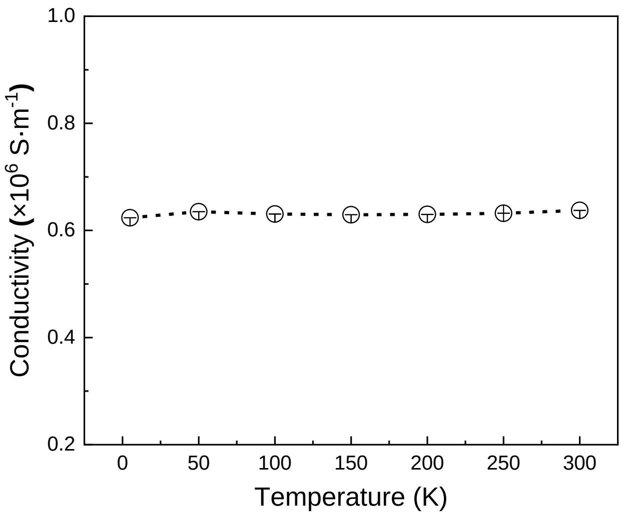

Figure S3. Temperature-dependent conductivity of the $PtTe_2$ thin films.

The Seebeck coefficient were measured simultaneously using a ZEM-3 system (ULVAC-RIKO, Japan) with a four-probe method as shown in Figure S4.

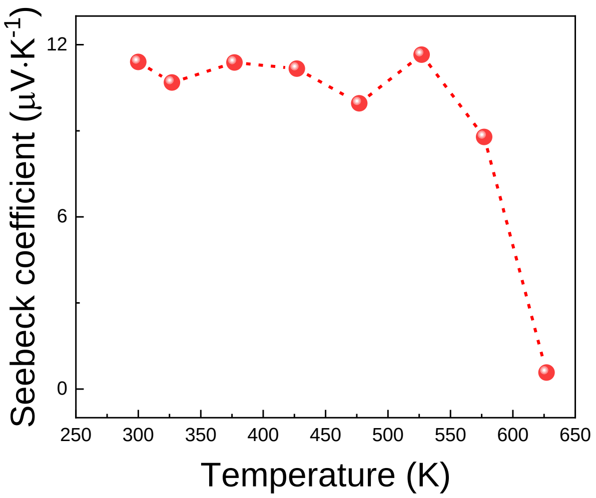

Figure S4. The Seebeck coefficient of $PtTe_2$ thin films as a function of temperature.

References

[1] Chen M. Y., Jiang T. R., Wang J. L., et al. Giant Photogalvanic Effect-Induced Terahertz Wave Emission in Wafer-Scale Type-II Dirac Semimetal PtTe. *Acs Applied Materials & Interfaces* **2025**,17, 4137.

[2] Ma H., Chen P., Li B., et al. Thickness-Tunable Synthesis of Ultrathin Type-II Dirac Semimetal PtTe2 Single Crystals and Their Thickness-Dependent Electronic Properties. *Nano Lett.* **2018**,18, 3523.