Thermal-induced strain control in scalable $PtTe_2$ films

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Platinum ditelluride ($PtTe_2$) has recently emerged as a prominent type-II Dirac semimetal, attracting significant interest due to its tilted Dirac cones and the resulting topological electronic and optical properties. [1,2] However, the transition from fundamental study to technological exploitation requires scalable, controllable growth techniques capable of producing high-quality films on diverse substrates.
Here, we present a robust and scalable synthesis route for large-area $PtTe_2$ films by a two-step process consisting of sputtering deposition of platinum precursor layers and tellurization in a tubular furnace. We demonstrate that by tuning the tellurization thermal parameters, it is possible to develop a substrate-versatile process and to deterministically control the structural and morphological properties of the resulting films. [3]
First, we investigate the role of thermal-induced strain during growth. We observed that the same tellurization process developed for silicon substrates proved to be critical on dielectric transparent silica substrates, leading to microscopic wrinkling in $PtTe_2$ films which is avoided by slowing down the process. Interestingly, we reversed this conclusion on silicon substrates to induce controlled microscopic corrugations by intentionally increasing the tellurization heating rate. Raman spectroscopy reveals the coexistence of tensile and compressive strains within these wrinkled structures, offering a pathway toward "wrinkle electronics" and strain-tailored devices.
Furthermore, we observed that increasing the tellurization thermal budget enables a transition in crystal orientation from (001) to (1-13)/(103) directions, a feature of high relevance for applications such as electro- and photocatalysis where surface reactivity is orientation-dependent.
Considering that the platinum precursor layers can be easily patterned by lithography and that tellurization occurs at temperatures compatible with back-end of line processes, these results demonstrate a versatile process for the integration of $PtTe_2$ into next-generation optoelectronics.

References

[1] M. Yan et al., Nat Commun 8, 257 (2017)
[2] S. Macis et al., Adv. Mater.2024, 36, 2400554
[3] M. Gardella et al., Phys. Status Solidi RRL. 2026, 20, e202500305