

Mapping Nanoscale Buckling in Atomically Thin Cr₂Ge₂Te₆

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Magnetic two-dimensional materials are a promising platform for novel nano-electronic device architectures. One such layered crystal is the ferromagnetic semiconductor chromium germanium telluride (Cr₂Ge₂Te₆) which recently attracted interest due to its potential for spintronics and memory applications. Here we investigate its properties from the structural standpoint using atomic resolution Scanning Transmission Electron Microscopy (STEM) and present the first atomic resolution images down to its monolayer limit [1]. We develop a novel technique that allows one to map the local tilt with unprecedented spatial resolution using only high-resolution images, enabling mapping of the topography and morphological variation of atomically thin crystals. Using it, we show that the Cr₂Ge₂Te₆ monolayer has an unusually large out-of-plane rippling, with local tilt variation reaching 20° over few nm length scales. We hypothesize that such a strongly buckled structure originates from both point and extended lattice defects which are more prevalent in monolayer crystals. In addition, we correlate the structural observations with the band structure measurements using Angle-Resolved Photoemission Spectroscopy (ARPES). We believe that both the atomic scale insights we have gained on Cr₂Ge₂Te₆ and our novel approach to nanoscale topography mapping will benefit the development of van der Waals heterostructures in both fundamental and applied research.

References

[1] Carl A., Clark N. et al, *Advanced Functional Materials*, 36, e26564 (2026).

Figures

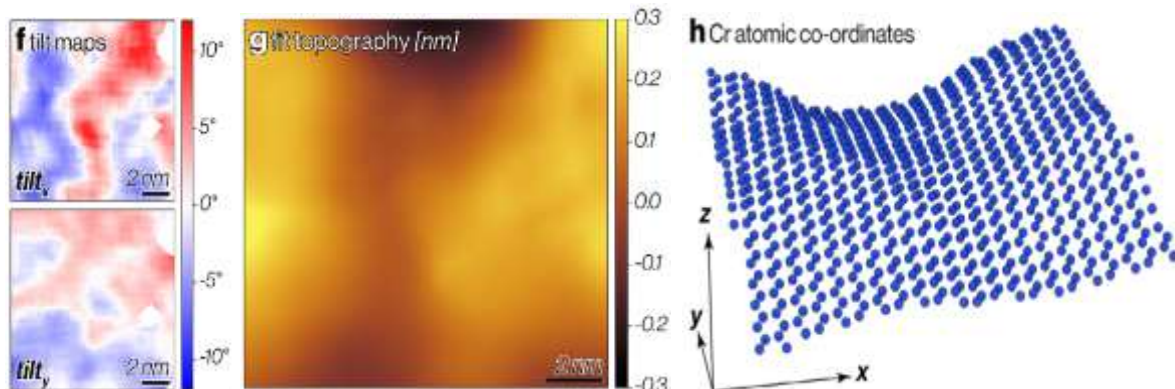


Figure 1: 3D buckled structure in monolayer Cr₂Ge₂Te₆. **f)** Maps of local tilt. **g)** Height map obtained by a minimization of the difference between the gradients of the height map and the experimentally identified tilts **f)**. **h)** 3D map of Cr atomic positions inferred from the height map **g)**.