MIP: PARADIM at Cornell University, DMR-2039380

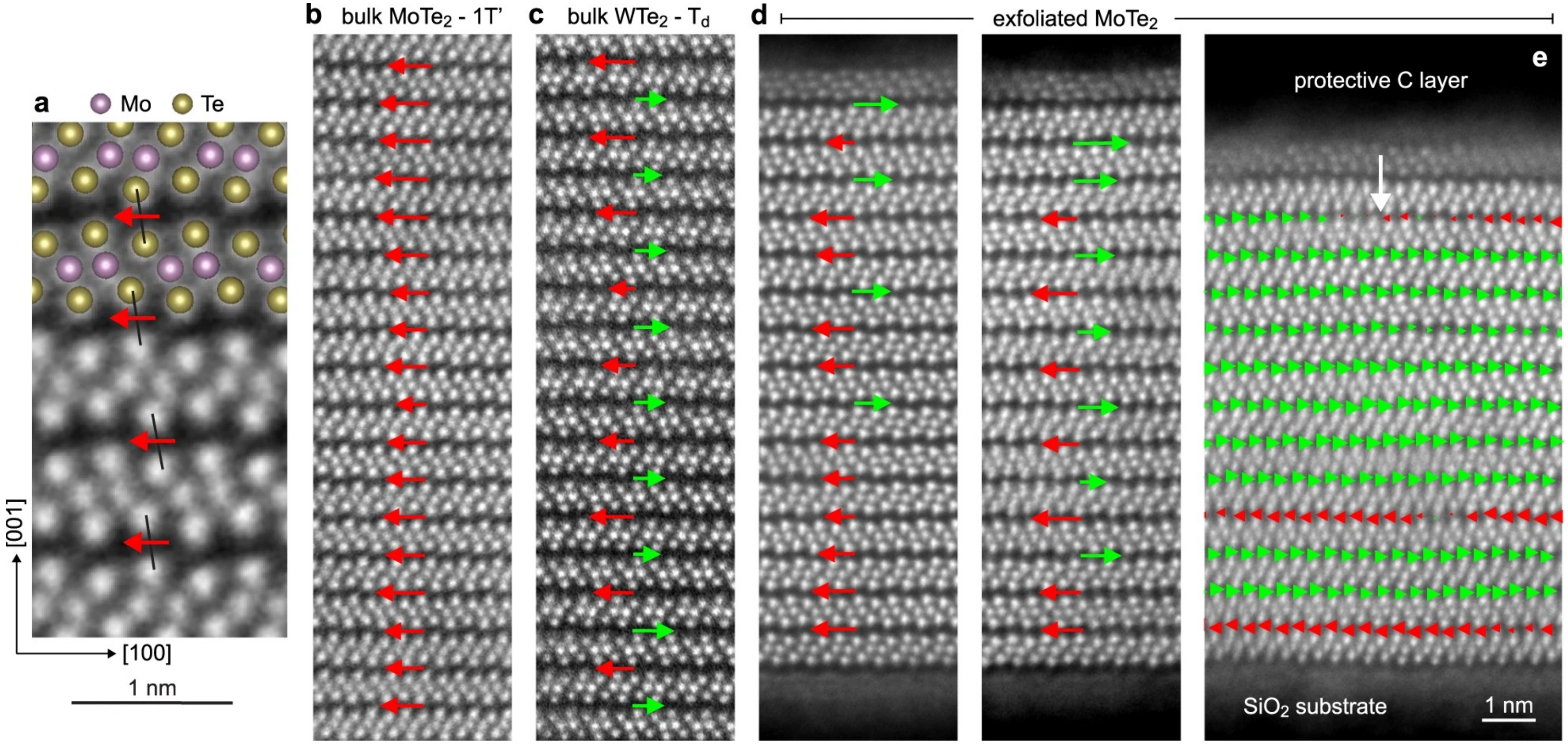
Local User Project - 2023

Emergent layer stacking arrangements in c-axis confined $MoTe_2$

**Judy J. Cha and Lena F. Kourkoutis (Cornell), Yimei Zhu (BNL),
Peijun Gou (Yale), Yanbing Zhu, Felipe Jornada, and Evan J. Reed (Stanford)**

In layered van der Waals (vdW) solids, exotic quantum phenomena can be engineered via the layer stacking. For instance, the twist angle in bilayer graphene influences the low-energy electronic band structure, allowing for control over magnetic, superconducting, and topological phases. An additional control parameter is the in-plane displacement between layers, *i.e.*, the layer stacking order. Here, **PARADIM's electron microscopy facility** is used to directly visualize the in-plane displacement—the inter-layer shift (**red** and **green arrows**) of $MoTe_2$.

For the 1T' phase of $MoTe_2$ all displacement points in the same direction (**b**). In stark contrast, a 9-nm-thin flake of $MoTe_2$ scrambling of the displacement (**d** to **e**); the stacking lacks long-range order and appears highly disordered and even changes in stacking direction are observed (white arrow in **e**).



The study raises important questions regarding the electronic structure, topology, and charge transport mechanisms in exfoliated TMD flakes, and how thickness may influence layer stacking in other 2D materials which exhibit stacking-dependent functionality, *e.g.*, magnetic 2D materials. This work also highlights the importance of atomic-scale analysis in determining the structure of 2D materials.

J.L. Hart, *et al.* Nat. Commun. **14**, 4803 (2023).

Data DOI: 10.34863/bm64-9w84.