

Supporting Information

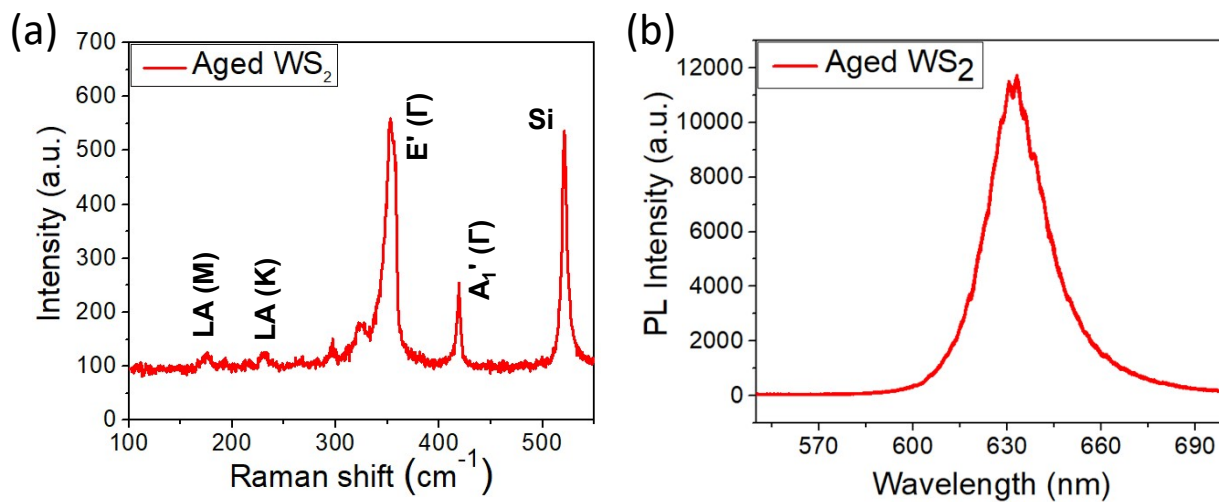


Fig. S1. (a) Raman and (b) PL spectra of the aged monolayer WS₂ confirming the presence of monolayer¹.

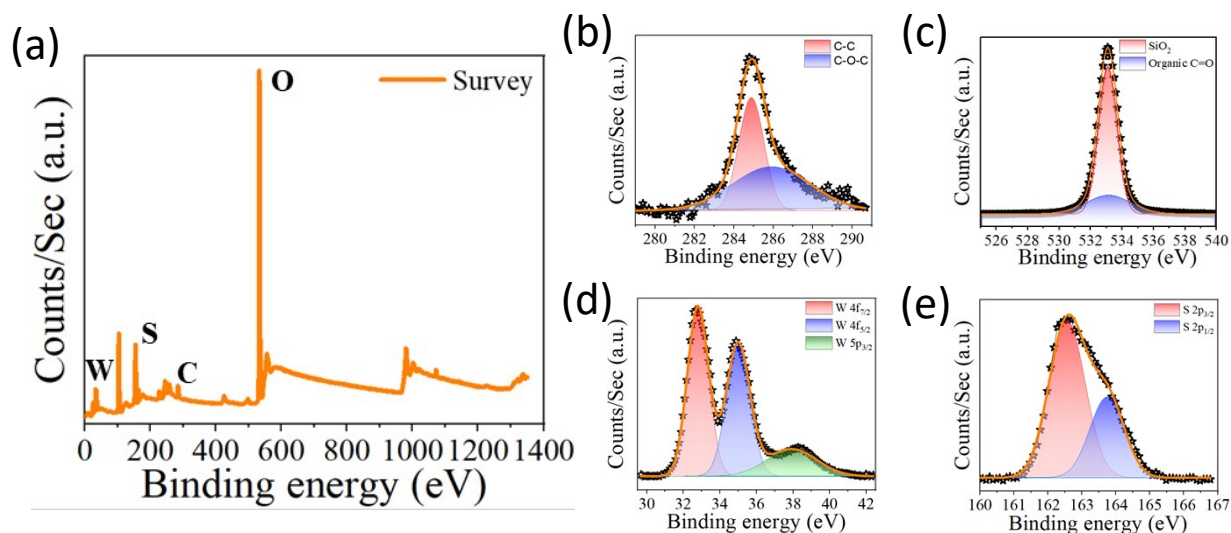


Fig. S2. XPS plot of freshly grown monolayer WS₂. (a) Survey scan, (b) C scan, (c) O scan, (d) W scan, and (e) S-scan are presented.

Supporting Video Link: <https://bit.ly/3CTsd58> (The video shows the initiation of wear near wrinkles)

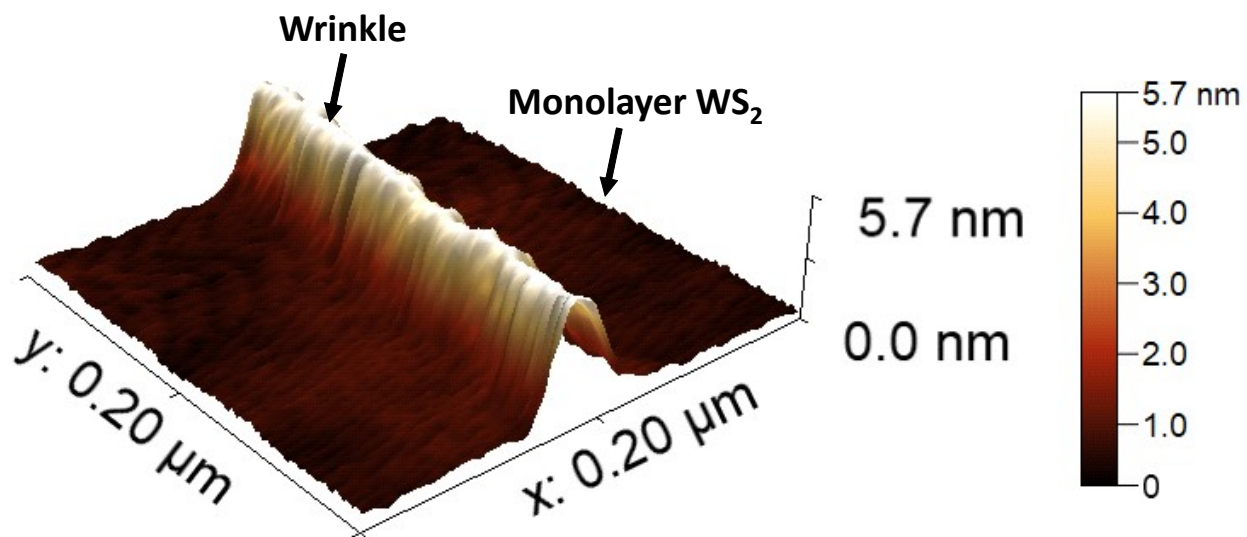


Fig. S3. High-magnification 3D topographic AFM image of a wrinkle shows height contrast between the wrinkle and the monolayer WS₂.

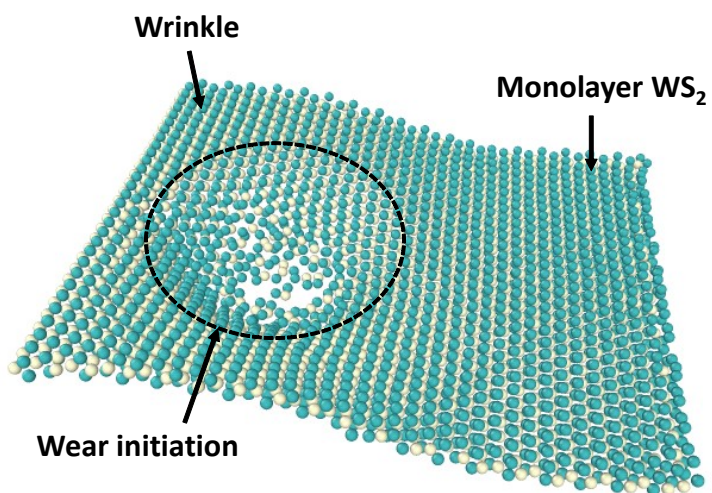


Fig. S4. A snapshot of MD simulation shows wear initiation (black color dashed circle) under the tip near the wrinkle.

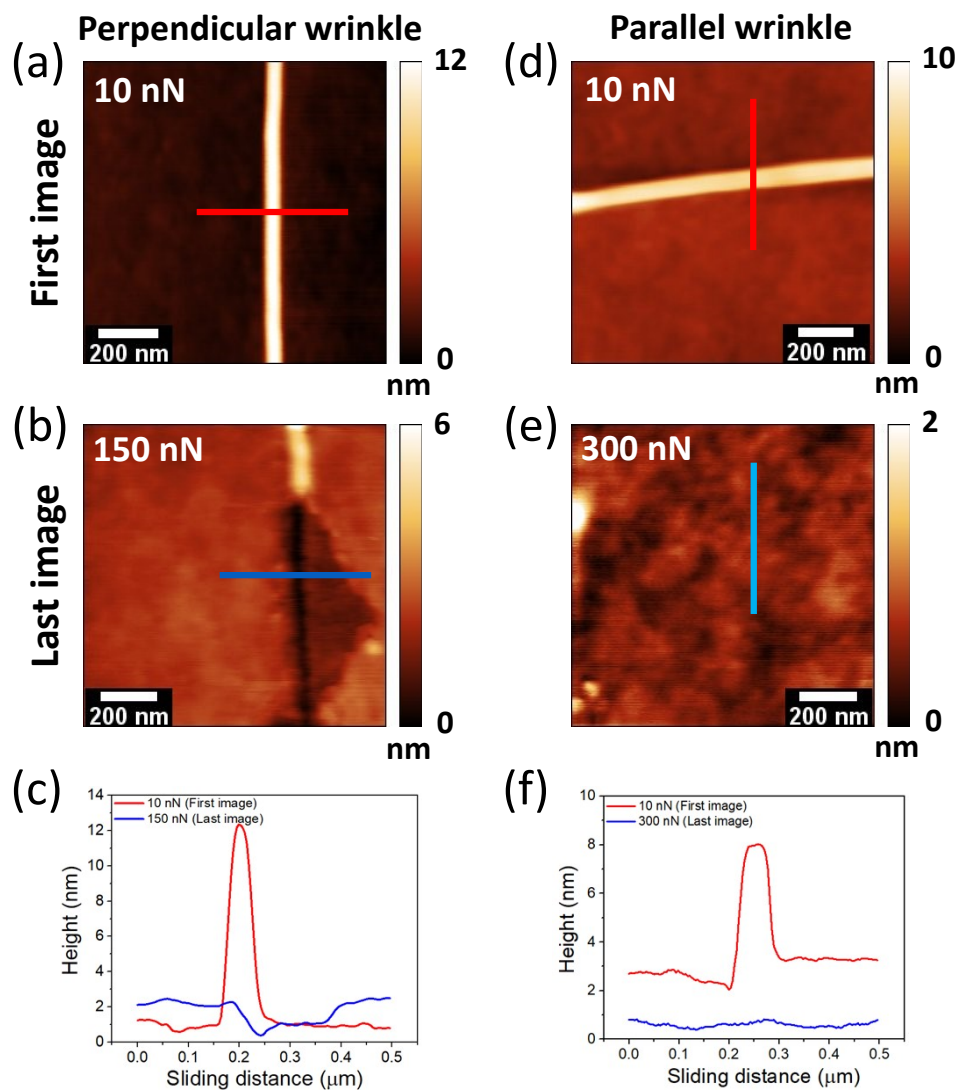


Fig. S5. Topographic image of the perpendicular and parallel wrinkle at low and high normal loads in (a), (b), (d), and (e). (c) and (f) show topographic line profile across wrinkles (red and blue color lines in topographic images) at two different normal loads revealing wear of perpendicular wrinkle and flattening of the wrinkle oriented parallel to sliding direction.

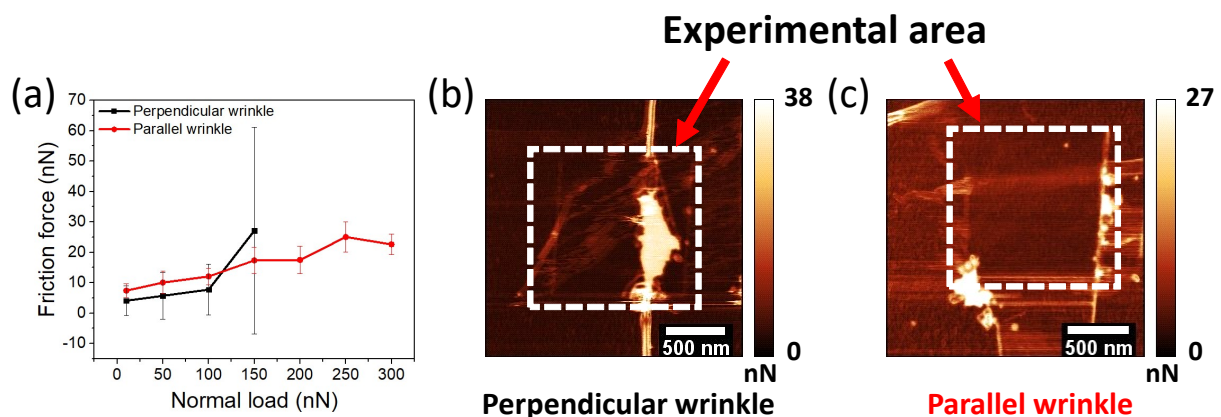


Fig. S6. (a) Friction vs normal load shows a jump in the friction at lower normal load of ~ 150 nN for perpendicular wrinkle whereas no such sudden jump is observed for parallel wrinkle. Zoomed-out friction force map of the experimental area (white color dashed square) showing (b) perpendicular wrinkle with worn region where friction contrast is much brighter and (c) parallel wrinkle with uniform friction contrast due to lack of wear.

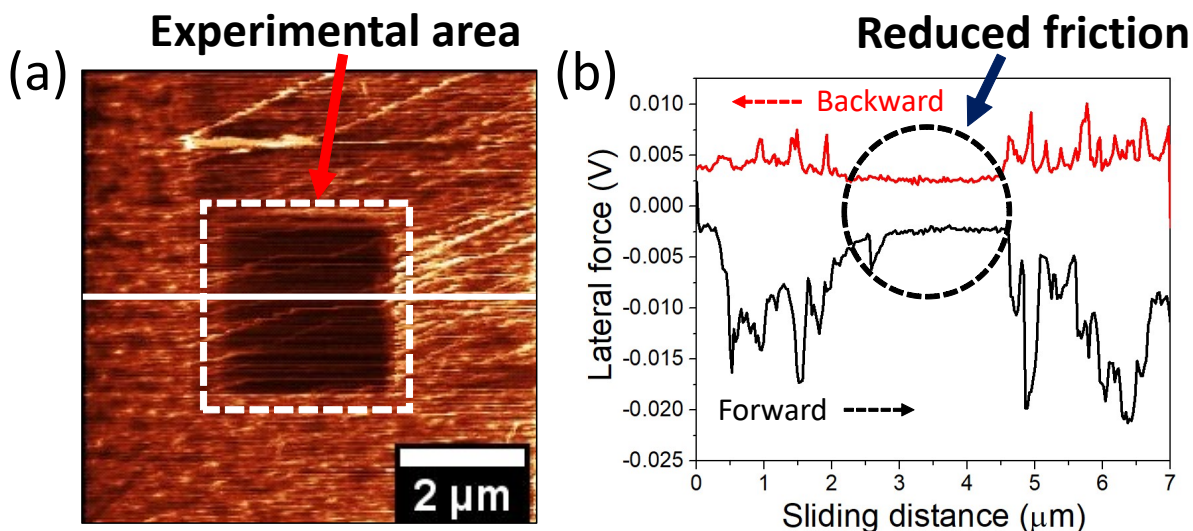


Fig. S7. (a) Zoomed-out friction force map of the experimental region (in white color dashed square). (b) The line profile across the friction force map (white color solid line drawn in the middle) shows a reduced friction in the middle highlighted by black color dashed circle.

Reference:

- 1 H. Rai, D. Thakur, D. Kumar, A. Pitkar, Z. Ye, V. Balakrishnan and N. N. Gosvami, *Appl. Surf. Sci.*, 2022, **605**, 154783.