IMPACT OF STRUCTURAL DEFECTS ON NANOTRIBOLOGICAL BEHAVIOR OF CHEMICAL VAPOR DEPOSITED WS_2 MONOLAYERS

Himanshu Rai[1]*, Ilia Ponomarev[1], Deepa Thakur[2], Tomas Polcar[1], Viswanath Balakrishnan[2], Nitya Nand Gosvami[3]

[1]Department of Control Engineering, Faculty of Electrical Engineering, Czech Technical, University in Prague, Czech Republic

[2]School of Mechanical and Materials Engineering, Indian Institute of Technology Mandi, Himachal Pradesh, India 175075

[3]Department of Materials Science and Engineering, Indian Institute of Technology Delhi, Hauz Khas, New Delhi, India 110016

Corresponding authors*: raihiman@cvut.cz

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ABSTRACT

Structural defects in two-dimensional (2D) materials are ubiquitous and can influence the properties significantly [1]. The presence of structural defects in the graphene is detrimental to the tribological properties [2]; however, their effects on transition metal dichalcogenides (TMDs) remain largely unexplored. Here, we report the role of wrinkles and nanoscale void on the tribological behavior of the chemical vapor deposited (CVD) tungsten disulfide (WS_2) monolayers. In the presence of such defects, wear near the defects was initiated at significantly lower normal loads compared to the freshly grown WS_2 monolayer. This shows a significant reduction in load-carrying capacity in the presence of structural defects in CVD-grown WS_2 monolayers, which can limit its use as coatings, in form of additives or as reinforcements for engineering tribological applications.

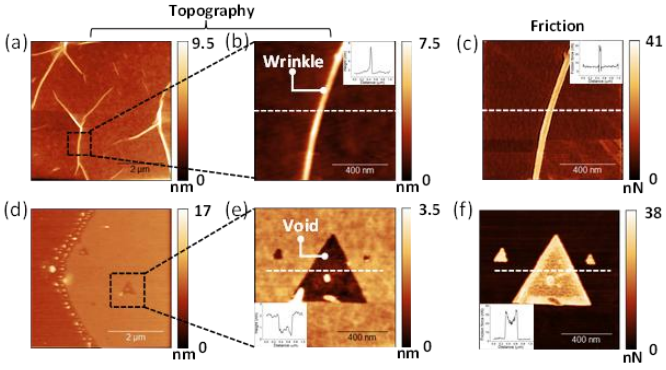

Fig.1: AFM topographic image of (a) wrinkles, (b) single wrinkle and height line profile (inset), and (c) friction map of the single wrinkle and the line profile (inset). Topographic image of (d) voids, (e) single void and depth line profile (inset), and (f) friction map of the void and the line profile (inset). The line profiles were taken across the white color dashed lines, as shown in the respective images.

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REFERENCES

[1] Lin, J.; Zhou, W. Defect in 2D Materials beyond Graphene. In Defects in Advanced Electronic Materials and Novel Low Dimensional Structures; Woodhead Publishing, 2018; pp. 161–187 ISBN 9780081020531.

[2] Tripathi, M.; Awaja, F.; Bizao, R.A.; Signetti, S.; Iacob, E.; Paolicelli, G.; Valeri, S.; Dalton, A.; Pugno, N.M. Friction and Adhesion of Different Structural Defects of Graphene. ACS Appl. Mater. Interfaces 2018, 10, 44614–44623