Unravelling the nature of strong interaction between TMDCs and metals

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Strong interaction between transition metal dichalcogenides (TMDCs) and gold leads to a reliable production of large monolayers (1L) and the appearance of intriguing phenomena in optical spectroscopy, electron spectroscopy, and electrochemistry [1]. Other metals are theoretically predicted to interact even more strongly with TMDCs than Au [2] but are prone to oxidation, preventing successful exfoliation in air [3]. We exfoliated large-area 1L TMDCs on various metals (Figure 1a) under an inert atmosphere and characterized the resulting monolayers using various techniques, particularly Raman spectroscopy (Figure 1b). The Raman spectra show significant differences between different metals in the positions, shapes, and intensities of the E and A_1 modes. We explain the observed Raman spectra by discrepancies between the TMDCs and metal lattices, work functions, and morphology. Our findings shed light on the nature of the strong TMDC-metal interaction, open the possibility of using other-than-Au substrates for large-area exfoliation, and aid in improving the efficiency of the exfoliation process.

References

[1] M. Velický, G. E. Donnelly, W. R. Hendren, S. McFarland, D. Scullion, W. J. I. DeBenedetti, G.C. Correa, Y. Han, A. J. Wain, M. A. Hines, D. A. Muller, K. S. Novoselov, H. D. Abruña, R. M. Bowman, E. J. G. Santos, and F. Huang, ACS Nano, 10 (2018) 10463
[2] M. Farmanbar and G. Brocks, Physical Review B, 8 (2016) 085304
[3] M. Velický, G. E. Donnelly, W. R. Hendren, W. J. I. DeBenedetti, M. A. Hines, K. S. Novoselov, H. D. Abruña, F. Huang, and O. Frank, Advanced Materials Interfaces, 23 (2020) 2001324

Figures

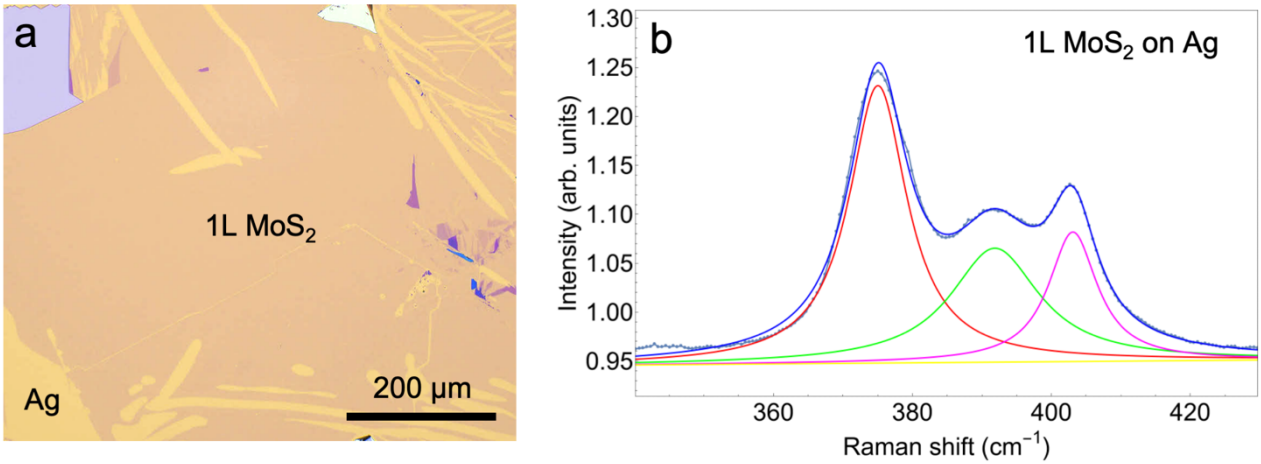

Figure 1: a. Optical image of a large-area 1L MoS_2 exfoliated on an Ag substrate under an inert atmosphere. b. Raman spectra of 1L MoS_2 on Ag showing the region with the main vibration modes.