Two-dimensional transition metal Dichalcogenides (TMDCs) based ion-sensing field-effect transistors for advanced biosensor applications

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As we all know a very famous idiom, "Prevention is better than cure", Biosensors are of great importance for human species to lead a healthy life by efficient and accurate detection of biomarkers that may lead to life threaten diseases. An ideal biosensing platform should have low cost, easy to use, exhibit fast response time, low limit of detection, high sensitivity, selectivity and stability. However developing such an ideal biosensing platform has been a major challenge for researchers.

2D semiconducting TMDCs materials, because of their extraordinary properties such as high surface binding sites, tunable band gap and low leakage current are found to exhibit high sensitivity and selectivity in label free field effect transistor (FET) based biosensors [1, 2]. However, most of the studies are done on high quality small flakes [3]. There is a need of scalability and integration for such biosensing platforms to overcome real world problems. Progress in 2D TMDCs material synthesis with high quality and uniformity at wafer scale [4] opens new doors for system integration of such highly sensitive platforms for advance biosening applications. Here, we would like to present our work of studying the performance of 2D TMDCs based Ion sensitive field effect transistors (ISFETs) devices by exploring different solid liquid interfaces, channel effects (geometry, length and width) with high stability and system integration of the devices at wafer scale to exploit advance biosensing applications.

References

[1] Deblina Sarkar, W.L., Xuejun Xie, Aaron C. Anselmo, Samir Mitragotri and Kaustav Banerjee, ACS Nano, 2014. 8(4): p. 3992-4003.
[2] Nam, H., et al., Journal of Vacuum Science & Technology B, Nanotechnology and Microelectronics: Materials, Processing, Measurement, and Phenomena, 2015. 33(6).
[3] Sanjay, S., et al., npj 2D Materials and Applications, 2021. 5(1).
[4] Cun, H., et al., Nano Research, 2019. 12(10): p. 2646-2652.

Figures

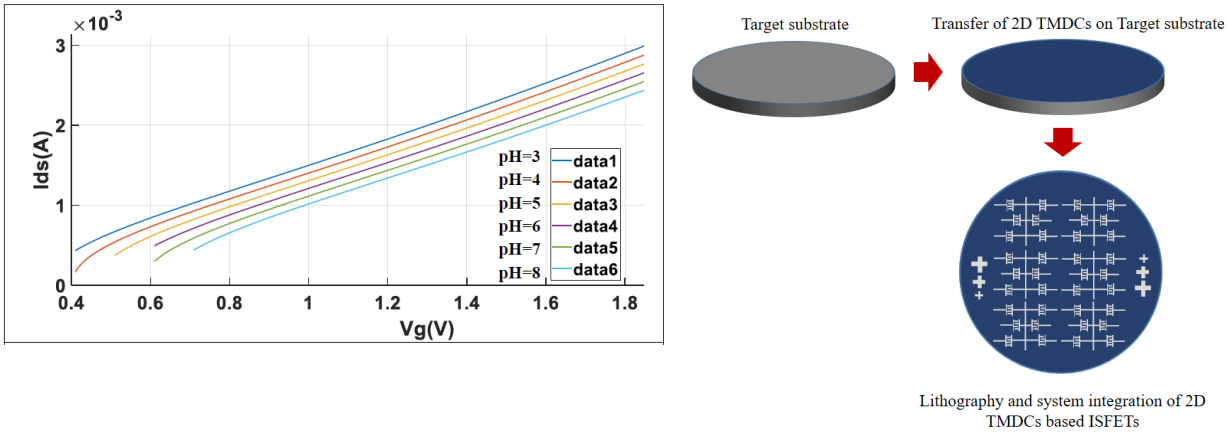

Figure 1: Theoretical simulation to model 2D semiconducting ISFET (left): I_{ds} vs V_g characteristics for different pH values. Schematics illustration (right) of wafer scale fabrication of 2D TMDCs based ISFET devices for advance biosensor applications.