WSe_2 defect engineering by Ne ion bombardment and growth of semimetal Sn

Yen-yu Lai (賴彥諭)[1], Ruei-jhe Tu (涂瑞哲)[1], Wei-nian Chen (陳威年)[1], and Chun-liang Lin (林俊良)[1*]

[1]*Department of Electrophysics, National Yang Ming Chiao Tung University, Hsinchu, Taiwan*

gtcb2481@gmail.com

Abstract

Even transition metal dichalcogenide (TMD) materials offer the potential to further support device scaling, but the development of TMD-based devices is impeded by high contact resistance up to this time. One contributing factor is the intrinsic van der Waals (vdW) gap at the metal-TMD interface, which behaves as an additional tunneling barrier. This results in high contact resistance in TMD devices. Several methods have been proposed to improve contact resistance, such as introducing chalcogen vacancies and using semimetal electrodes. Chalcogen vacancies eliminate the vdW gap and facilitate interfacial charge transfer, leading to a lower Schottky barrier. Semimetal electrodes have also been shown to reduce contact resistance in some studies. This inspired us to merge these two methods to further enhance the interface by growing semimetal electrodes on defective TMDs.

In this study, we investigated the growth of a semimetal element, Sn, on defective WSe_2 using a scanning tunneling microscope (STM). We first maximized defect density on the WSe_2 surface through ion bombardment with different ion sources (Ar and Ne). Using Ne was the most efficient in introducing defects. On the Ne-bombarded surface, four types of defects were observed, with multiple and single Se vacancies being the most prevalent. We successfully grew Sn on the defective WSe_2 surface and compared its growth behavior with that on as-cleaved surfaces. The Sn islands nucleated at defect sites, indicating a stronger interaction between Sn and TMD. Our study revealed that the interface between semimetal and TMD can be improved by introducing defects on the TMD surface, expanding the feasibility of applying 2D materials in next-generation devices.

Keywords - Defect engineering, Ne ion bombardment, Semimetal contact, Adaptability to different TMDs.