
Chueh-Cheng Yang¹

Shu-Jui Chang¹

Yuan-Chieh Tseng¹

Chia-Hsin Wang²

¹National Chiao Tung University, Hsinchu, Taiwan(ROC)

²National Synchrotron Radiation Research Center, Hsinchu, Taiwan(ROC)

amaranth.mse07g@nctu.edu.tw

Investigation of Gas Sensing Efficiency and Mechanism Based on P-type MoS₂

Transition metal dichalcogenides have attracted significant attentions due to their unique chemical and physical properties. These materials are widely applied to various applications, and one of them is gas sensing technology, due to their large surface-to-volume ratio and relative low operation temperature. In this work, we fabricated gas sensors based on P-type MoS₂ doped with niobium(Nb), and we explored the sensing efficiency and sensing mechanism of CO₂ and CO. With a relatively high Nb dopant concentration, the sensor response showed a decrease in sensitivity (Fig.1), which was likely attributed to a high metallic NbS₂ ratio in the semiconducting MoS₂ film [1].

The resistance of P-type MoS₂ appeared to increase while sensing both CO and CO₂, and we found that such mechanism was associated with electron transfer from gas molecules to the sensor [2]. Furthermore, we used in-situ x-ray absorption spectroscopy (XAS) and ambient-pressure x-ray photoelectron spectroscopy (APXPS) techniques at national synchrotron radiation research center (NSRRC) to probe the interactions between gas and MoS₂ during the gas absorbing process. The results (Fig.2) not only confirmed the electron donation from gas molecules but also showed that the interactions mainly arose from surface sulfur reacting with gas molecules.

References

- [1] Sun Young Choi, et al., ACS Appl. Mater. Interfaces, 9 (2017) 3817
- [2] Byungjin Cho, et al., Sci. Rep., 5 (2015) 8052

Figures

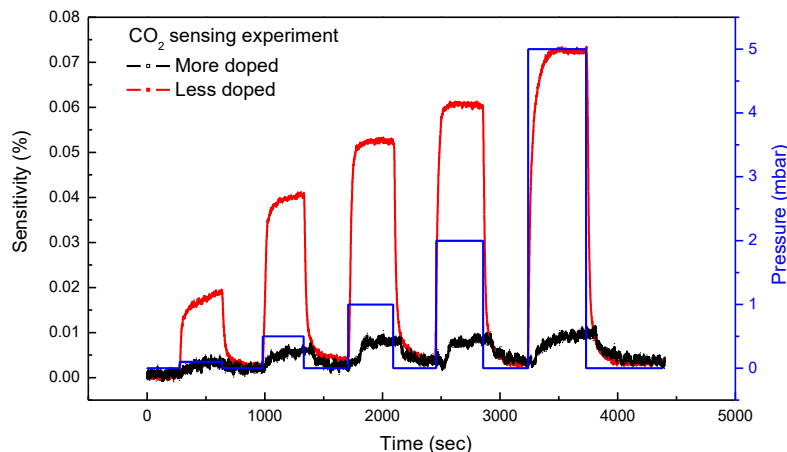


Figure 1: MoS₂ sensor with different doping levels in response to various CO₂ pressures.

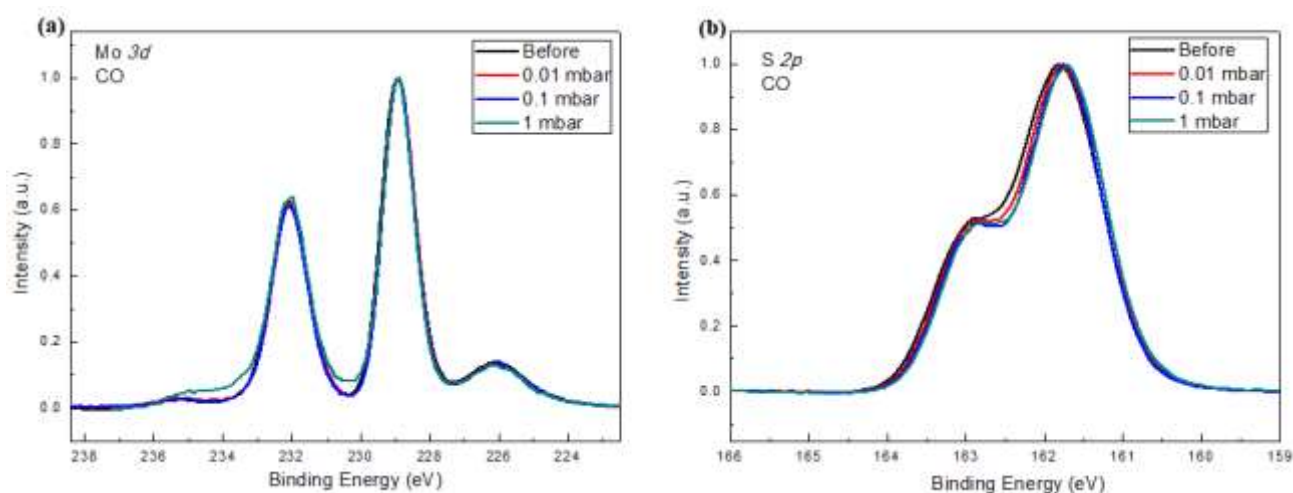


Figure 2: (a) Mo 3d spectrum remains unchanged under different CO pressures, while (b) S 2p spectrum shifts toward lower binding energy as a result of the shielding effect by electron donation.

Acknowledgement

This work was financially supported by the “Center for the Semiconductor Technology Research” from The Featured Areas Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education (MOE) in Taiwan and supported in part by the Ministry of Science and Technology, Taiwan, under Grant MOST-108-3017-F-009-003. Also, this work was support in part by the Ministry of Science & Technology, Taiwan, under Research of Excellence (RoE) Program, MOST 108-2633-E-009-001.