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Si-MoS₂ Vertical Heterostructure for High Responsivity Photodetector

We demonstrate the photodiode characteristics based on mechanically exfoliated multilayer MoS₂/p-type silicon heterojunction by optimizing the thickness of the MoS₂ layer. Among devices, 48-nm thickness MoS₂ device showed the best performance with the responsivity (R) of 76.1 A/W, the detectivity (D^*) of 1.6×10^{12} Jones, and the noise equivalent power (NEP) of 7.82×10^{-15} A/Hz^{1/2} at an external reverse bias, which is approximately 100-fold improvement of the R compared to the commercial Si p-i-n photodiode with the R below 1 A/W. In addition, the device exhibited zero bias operation (photovoltaic characteristic) with the open-circuit voltage (V_{oc}) of 0.5 V and the short-circuit current density (J_{sc}) of 161 mA/cm². Indeed, this p-n vertical van der Waals heterojunction exhibited good photoresponse characteristics. These results could contribute to the application of MoS₂/Silicon heterojunction toward optoelectronics such as photodetectors [1] and solar cells [2].

References

- [1] Wang, L. et al., Adv. Funct. Mater., 25 (2015) 2910-2919
- [2] Tsai, M.-L. et al., ACS Nano, 8 (2014) 8317-8322

Figures

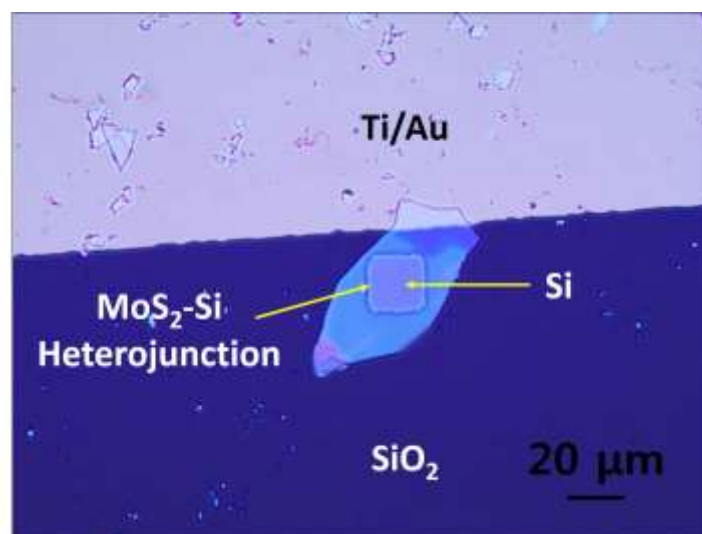


Figure 1: Optical microscope image of the photodetector.