Enhancing Light–Matter Interactions in MoS_2 by Copper Intercalation

Chen Stern,
Avraham Twitto,[1,2] Rifael Z. Snitkoff,[1,2] Yafit Fleger,[2] Sabyasachi Saha,[4,7] Loukya Boddapati,[4] Akash Jain,[5] Mengjing Wang, [3] Kristie J. Koski,[3] Francis Leonard Deepak,[4] Ashwin Ramasubramaniam,[6] and Doron Naveh [1,2,*].

[1]*Faculty of Engineering, Bar-Ilan University, Israel.*
[2]*Institute for Nanotechnology and Advanced Materials, Bar-Ilan University, Israel.*
[3]*Department of Chemistry, University of California Davis, USA.*
[4]*Nanostructured Materials Group, International Iberian Nanotechnology Laboratory, Portugal.*
[5]*Department of Chemical Engineering, University of Massachusetts, USA.*
[6]*Department of Mechanical and Industrial Engineering, University of Massachusetts, Amherst, USA.*
[7]*Electron Microscopy Group, Defence etallurgical Research Laboratory (DMRL), yderabad, India.*
chen.stern@biu.ac.il

Abstract

The intercalation of layered compounds opens up a vast space of new host–guest hybrids, providing new routes for tuning the properties of materials. Here, we show that uniform and continuous layers of copper can be intercalated within the van der Waals gap of bulk MoS_2 resulting in a unique Cu-MoS_2 hybrid. The new Cu-MoS_2 hybrid, which remains semiconducting, possesses a unique plasmon resonance at an energy of ~1eV, giving rise to enhanced optoelectronic activity. Compared with high-performance MoS_2 photodetectors, copper-enhanced devices are superior in their spectral response, extends into the infrared and also in their total responsivity that exceeds 104 A/W. The Cu–MoS_2 hybrids hold promise for supplanting current night-vision technology with compact, advanced multicolor night vision.

References

[1] Stern, C., et al., Enhancing Light–Matter Interactions in MoS_2 by Copper Intercalation. Advanced Materials, 2021. 33(23): p. 2008779.

Figures

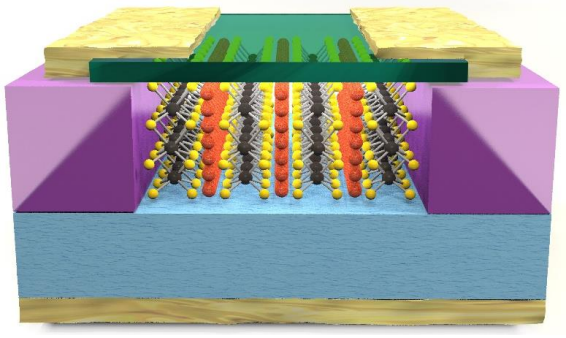

Figure 1: Graphical illustration of the cross-section of a VA-MoS_2 (yellow and black atoms)–Si (light blue) heterostructure photodiode device intercalated by Cu (red atoms).

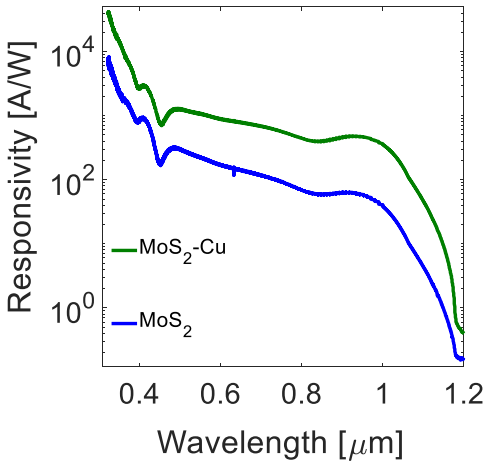

Figure 2: Responsivity versus wavelength of the bare-MoS_2 device (blue) and the Cu-intercalated MoS_2 device (green).