Van der Waals Materials for Polarization-Sensitive All-2D Photodetectors

Cédric Alexander Cordero Silis[1]
Jan Hidding[1], Daniel Vaquero[1,2], Konstantinos Rompotis[1], Harshan Madeshwaran[1], Jorge Quereda[3] and Marcos H. D. Guimarães[1]
[1]*Zernike Institute for Advanced Materials, University of Groningen, The Netherlands.*
[2]*Nanotechnology Group, USAL—Nanolab, Universidad de Salamanca, E-37008 Salamanca, Spain*
[3]*Departamento de Física de Materiales, GISC, Universidad Complutense de Madrid, E-28040 Madrid, Spain*
c.a.cordero.silis@rug.nl

Light detectors are key components in photonic circuits, converting light information into electronic signals. Van der Waals (vdWs) materials provide an excellent platform for photonics due to their low dimensionality and strong light-matter interaction.

In this presentation, I will show the use of phase-engineered two-dimensional (2D) transition-metal dichalcogenides (TMDs) for optoelectronic applications.[1] Using laser-induced phase engineering, we modify the crystal structure of $MoTe_2$ from the semiconducting 2H phase to the semi-metallic 1T'. With these lateral heterostructures we are able to show orders of magnitude improvement on the operation speeds and unveil the photocurrent mechanisms in these devices.

Additionally, I will show that the low-symmetry $CrPS_4$ vdWs crystal can be used as a photodetector with high polarization sensitivity.[2] By exploiting the crystal anisotropy of this material, we are able to show over 70% polarization contrast in the photocurrent in our devices, much higher than the contrast in optical absorption alone. Finally, we correlate the photoresponse to the excitation of specific states, relating their symmetry to the electronic transport anisotropy.

Our results highlight the versatility of vdWs materials for designing tunable, high-performance optoelectronic devices and demonstrate their potential for highly sensitive all-2D photonic detectors.

References

[1] Jan Hidding, Cédric A. Cordero-Silis, Daniel Vaquero, Konstantinos P. Rompotis, Jorge Quereda & Marcos H.D. Guimarães, *ACS Photonics*, 10 (2024) 4083-4089.
[2] Cédric A. Cordero-Silis, Harshan Madeshwaran & Marcos H.D. Guimarães. Manuscript in preparation.

Figures

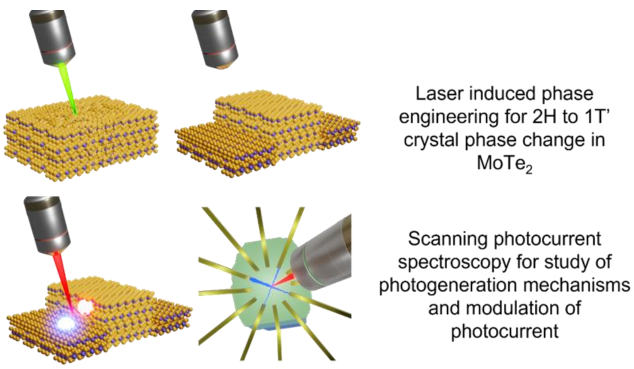

Figure 1: Use of light for crystal phase engineering in a 2D TMD, inducing a 1D metal-semiconductor junction. Scanning photocurrent spectroscopy as a technique to study the photocurrent generation mechanism and polarization dependent response in high and low symmetry crystals.