Living on the edge: 1D van der Waals materials by design for nanophotonic applications

Sonia Conesa-Boj, Luigi Maduro, Abel Brokkelkamp, Jaco ter Hoeve, and Isabel Postmes

Kavli Institute of Nanoscience, Delft University of technology, 2628CJ, Delft, The Netherlands
s.conesaboj@tudelft.nl

The fabrication of 2D materials such as transition metal dichalcogenides (TMDs) in geometries beyond the standard platelet-like configuration exhibits significant challenges which severely limit the range of available morphologies. Furthermore, industrial applications based on TMD nanostructures with non-standard morphologies require full control on the size-, morphology-, and position on the wafer scale. Such a precise control remains an open problem of which solution would lead to the opening of novel directions in terms of optoelectronic and nanophotonic applications. Here we present recent studies on a novel strategy to fabricate position-controlled nanopillars (NPs) based on TMDs materials at the wafer scale [1]. Realizing the precise localization of the TMDs NPs enables a highly localized nonlinear signal required for many nanophotonic applications. Furthermore, an in-depth study of the local electronic properties of such TMD nanomaterials with non-standard geometries requires the combination cutting-edge transmission electron microscopy techniques with machine learning. I will describe the EELSfitter STEM-EELS data analysis framework [2] which makes possible the spatially-resolved determination of crucial properties of TMD nanomaterial such as the bandgap and the complex dielectric function.

References

[1] L. Maduro, M. Noordam, M. Bolhuis, L. Kuipers, and S. Conesa-Boj, Adv. Funct. Mater, (2021) 2107880

[2] A. Brokkelkamp, J. ter Hoeve, I. Postmes, S. E. van Heijst, L. Maduro, A. V. Davydov, S. Krylyuk, J. Rojo, and S. Conesa Boj, ACS J. Phys. Chem. (2022), 1255

Figures

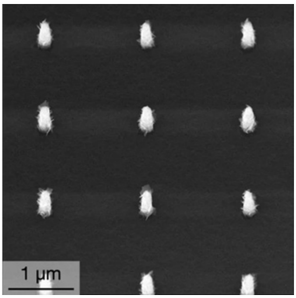

Figure 1: Scanning electron microscopy of 1D array of TMD-based nanopillars.

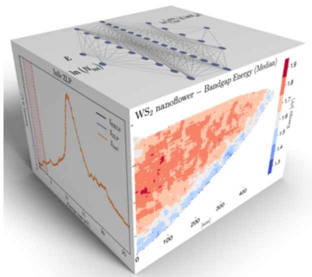

Figure 2: Machine learning for EELS data interpretation