2D Materials at the atomic scale: visualization and design

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The realization of novel TMD-based devices relies heavily on understanding the relation between structural and electrical properties at the nanoscale. The ultimate goal is that of crafting TMD nanostructures in a way that makes possible the tailored control of their properties. In this talk, recent studies illustrating novel fabrication approaches of TMD nanostructures based on combining top-down and bottom-up methods will be presented. These allow to control the resulting geometries and material combinations, making possible the realization of novel functionalities such as metallic edge states arising in MoS_2 nanowalls [1] and nanowires, enhanced nonlinear response in vertically oriented MoS_2 nanostructures [2], and surface and edge plasmons in WS_2 nanoflowers [3]. I will emphasize the crucial role that cutting-edge transmission electron microscopy techniques play in these studies, together with that of machine learning techniques [4] which make possible extract a wealth of novel information which would be lost otherwise. I also present recent developments were machine learning techniques from particle physics are used to realize a spatially-resolved determination of the bandgap and dielectric function in nanostructured TMD van der Waals materials.

References

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Figures

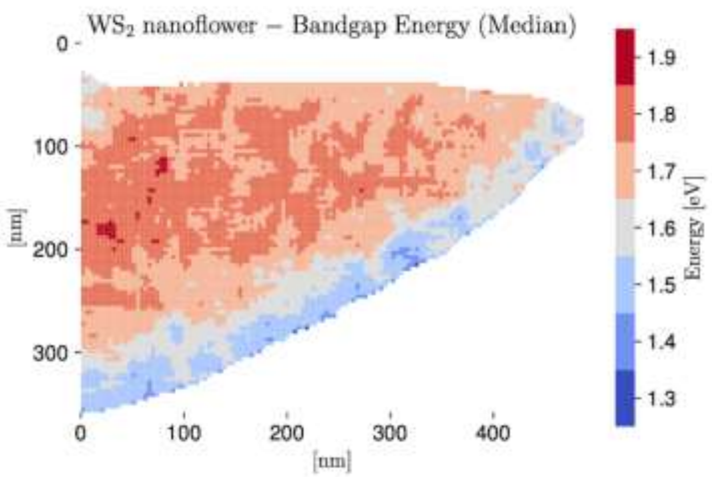

Figure 1: Spatially resolved determination of the bandgap of WS_2 flower-like nanostructures, where the zero-loss peak has been subtracted by means of deep learning techniques