Optoelectronic measurements on atomically thin $Mo_xW_{(1-x)}S_2$ nanoflakes

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The last decade, the scientific community has developed a broadening interest in atomically thin 2D materials; due to their attractive mechanical, thermal and electronic properties. In particular, transition metal dichalcogenides (TMD) have been on the peak of this research interest lately [1-5]. Focusing on their electronic properties, a point of great interest application-wise is band gap tuning. In bulk, materials, one of the major techniques used for this purpose consists on alloying materials with different band gaps, which has been also developed on atomically thin layers [1,2]. These works have shown the evidence of a band gap shift with the alloying degree in monolayers. This evidence is supported both theoretically (by density functional theory (DFT)) and experimentally (via photoluminescence).

In this contribution, we will present our low-loss monochromated EELS studies on $Mo_xW_{(1-x)}S_2$ single crystals with various alloying degrees (x=0, 0.3, 0.5, 0.7, 1). Our results show that even if there is no unequivocal proof of a correspondence between the number of layers and its band gap behavior, there is a clear correlation between the average gap of each sample and its alloying degree. For other features related to Van Hove singularities, there is a measurable shift of the peaks when modifying the number of layers within the same alloying degree. However, the shift of these peaks with the alloying degree is not conclusive except for MoS_2. To conclude, this study delves deeper into the optoelectronic properties of atomically thin 2D layer TMD alloys unveiling potential future applications for this kind of materials.

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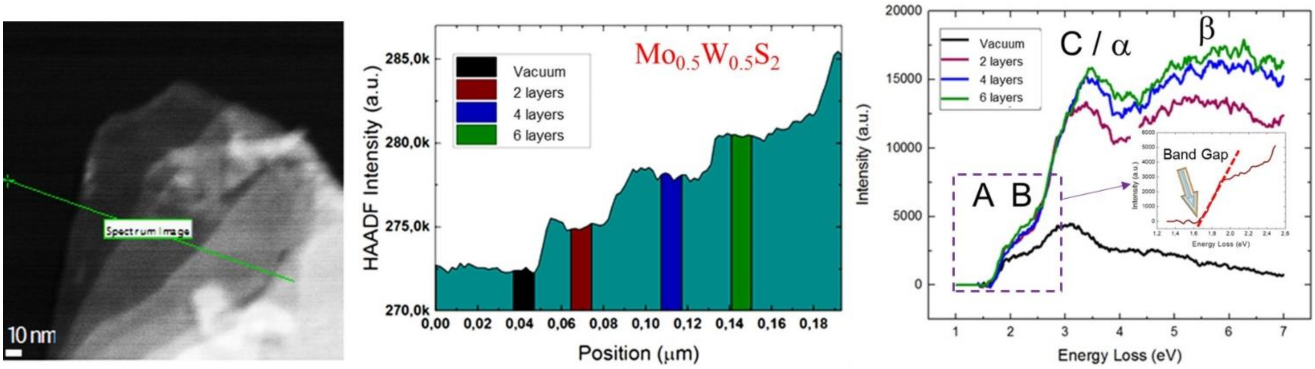

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Figure 1. a) HAADF-STEM micrograph of a $Mo_xW_{(1-x)}S_2$ sample flake showing a SPLI. b) Intensity profile obtained in Fig. 1a, highlighting the plateaus where the EEL spectra have been integrated. c) Integrated EEL spectra showing the band gap region - A,B excitons (purple square), the C exction and the Φ#177; and β Van Hove features.