2D nanomaterials beyond graphene: opportunities and challenges for selective gas sensing

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Keywords: two-dimensional nanomaterials, few-layer dichalcogenides, hybrid nanomaterials, gas sensing properties

1. SUMMARY:

This presentation gives an overview of the results reached in gas sensing with 2D nanomaterials different from graphene. In particular, it puts the focus on two-dimensional chalcogenides such as molybdenum or tungsten disulfide. It shows their synthesis, characterization and discusses their potential advantages for achieving more selective sensors.

2. MOTIVATION and RESULTS:

In the past few years, it has been emphasized experimentally and theoretically, that semiconducting MoS_2 or WS_2 are potential candidate materials for gas-sensing applications. It has been reported that in such metal dichalcogenide materials, structural defects, including point defects, grain boundaries, and edges play very significant roles in sensing properties. However, large-scale fabrication of sensors, their selectivity tuning, and noise reduction are still a challenge. Therefore, there is significant scope for exploring new materials with advanced properties. With the increasing demand of highly sensitive, selective, fast, and stable sensors, a series of sensing applications of nanoscale MoS_2 or WS_2 based composites and hybrids have been of growing interest [1]. In this contribution, I will discuss the synthesis, structural characterization and gas sensing properties of the two aforementioned metal dichalcogenides, either pure or hybridized to carbon nanotubes [2]. Gas sensing mechanisms will be introduced in light of the experimental findings and a discussion on their potential for ameliorating selectivity will be given. My presentation will end by a critical discussion about opportunities and challenges to be faced.

Acknowledgement:

We are thankful to Prof. J.F. Colomer (U Namur, Belgium), Dr. G. Deokar (KAUST, Saudi Arabia) and Dr. C. Bittencourt (U Mons, Belgium) for the fruitful collaboration in 2D materials. E. L. is supported by the 2018 ICREA Academia Award, A.A. is supported by the EU-COFUND and URV's Martí i Franquès pre-doctoral programs. F.E.A is supported by an URV's Martí i Franquès post-doctoral fellowship.

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[2] G. Deokar,* P. Vancsó, R. Arenal, F. Ravaux, J. Casanova-Cháfer, E. Llobet, et al. Adv.Mat. Interfaces 2017, 1700801.

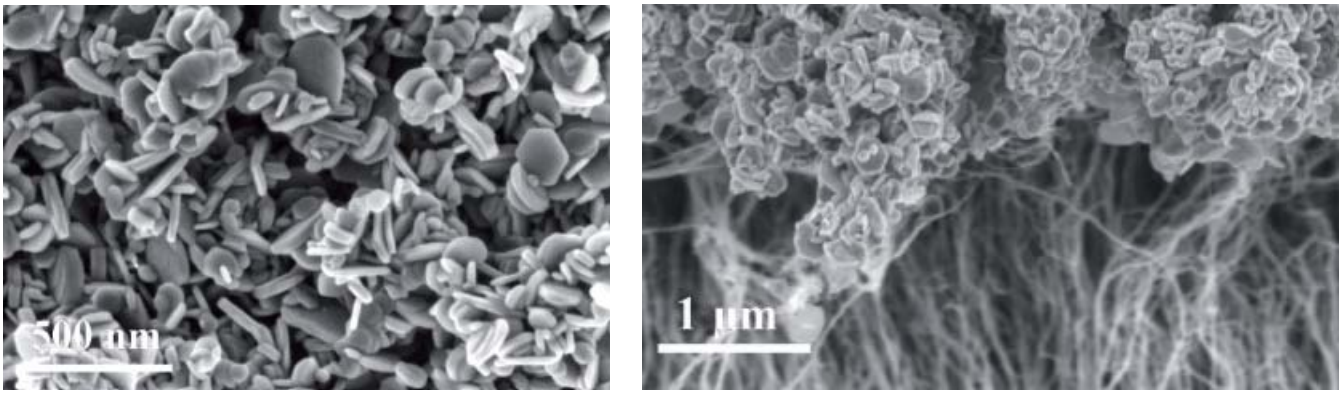

Figure 1: Nano-platelets of MoS_2 grown by the sulfurization of an ultrathin Mo film, sputter-deposited onto vertically aligned-CVD grown carbon nanotubes. Adapted from [2]

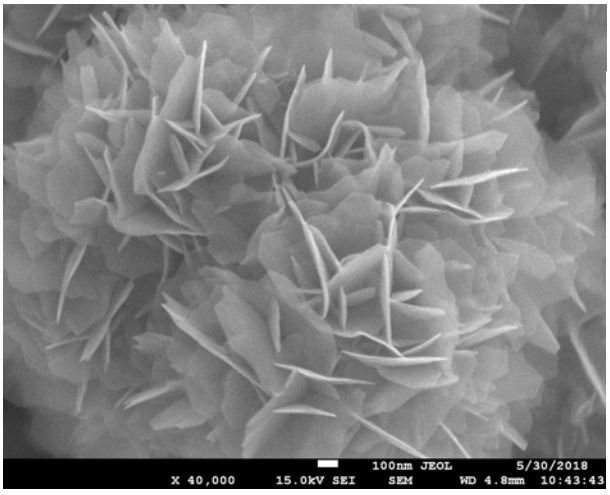

Figure 2: WS2 nano-platelets grown by the sulfurisation of CVD grown tungsten oxide nanowires.

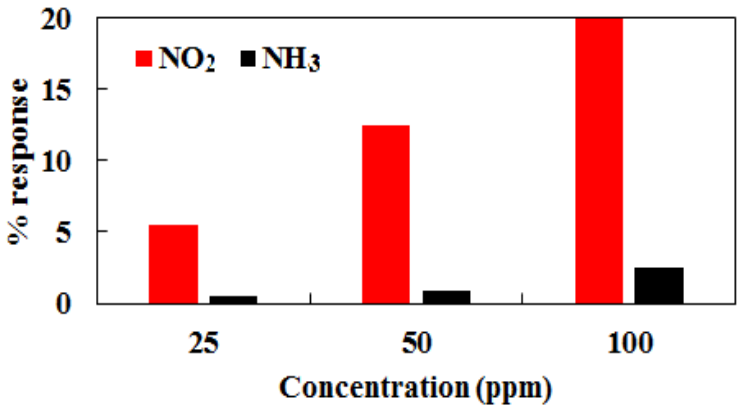

Figure 3: Selectivity analysis for MoS_2-CNT hybrids