Stability and Epitaxial Growth of Group V 2D Materials: Theory and *in situ* Observations

Matthieu Fortin-Deschênes[1], Olga Waller[1], Amanda Hébert[1], Pierre Levesque[2], Richard Martel[2], **Oussama Moutanabbir**[1]

[1]Department of Engineering Physics, École Polytechnique de Montréal, C. P. 6079, Succursale Centre-Ville, Montréal, Canada
[2]Département de Chimie, Université de Montréal, 2900 boulevard Edouard Montpetit, Montréal, Canada
Contact: oussama.moutanabbir@polymtl.ca

Abstract

Over the last few years, the existence and stability of several novel non-zero bandgap 2D materials have been theoretically predicted thus paving the way to developing a new class of graphene-like materials and heterostructures with superior functionalities. In this regard, group V 2D materials have been attracting a great deal of attention due to their unique physical and chemical properties such as a thickness dependent band gap in the visible to infrared range and anisotropic transport properties [1,2]. Up to date, 2D black phosphorus (2D-bP) and 2D antimony (2D-Sb) have been obtained by mechanical and liquid phase exfoliation from bulk crystals [3,4]. The exfoliated layers can be transferred and used to conduct fundamental studies and implement new device concepts. However, the large scale synthesis of these materials still remains a formidable task that is a crucial step toward scalable technologies. The epitaxial growth is by far the most promising method to synthesize these emerging 2D materials especially for mainstream electronic, optoelectronic and photonic applications. With this perspective, in this talk we present our recent studies of the epitaxial growth of group V 2D materials and real time investigations of their stability. Low-energy electron microscopy (LEEM) supported by *ab initio* calculations and kinetic Monte Carlo simulations are employed to elucidate the growth of 2D-(bP, As, Sb) materials, their thermal behavior and interaction with the substrate. In particular, we will discuss the mechanisms and dynamics of the thermal decomposition of 2D-bP [5] as well as the electronic properties and substrate-layer interaction of all three 2D materials on relevant growth substrates. Finally, we present *in situ* LEEM investigations of the growth of 2D-Sb and 2D-bP and discuss possible paths to achieve their epitaxial growth.

References

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