

LaMeS: Layered Structures of Metal Sulfides

Main area: BSR01_Synthesis and characterization of LMs beyond graphene

Keywords: novel 2D-materials; WS₂/SnS₂/MoS₂; sputtering; fundamental materials characterization; LM beyond graphene; large area deposition

Duration (months): 36

Total project funding: € 1.181.130

Abstract

Sputter deposition is a commonly used process and the possibility of using it in conjunction with 2D materials would constitute an enormous advantage for the industrial scale production in Europe. This has, however, not been accomplished yet. The reason for this is the energetic particle bombardment associated with conventional sputtering which may easily break the weak bonds in these types of sensitive materials. The conventional sputtering process promotes energetic particle flux onto the growing film which is normally beneficial for the film quality but may be very detrimental to a layered material. There is however a number of processing conditions that can be modified to significantly reduce the energetic bombardment. By using Monte-Carlo based software that is capable of simulating the sputtering process together with experimental feedback, the aim is to develop a sputtering process that is compatible with the layered structures. In this project, we propose to develop a sputter-deposition method for deposition onto sensitive layered structures as well as for the actual deposition of high quality layered sulphide structures, such as WS₂, MoS₂, SnS₂ and combinations thereof. Such materials combinations constitute novel layered materials structures and it is of major importance that such structures are developed in EU. The deposited films will further be characterized by using optical microscopy, atomic force microscopy (AFM), scanning tunneling microscopy (STM), scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction, Raman and photoluminescence spectroscopies, X-ray photoelectron spectroscopy (XPS) and hard X-ray photoelectron spectroscopy. Such characterization is important for understanding the fundamental physics of the layered structures and hetero structures. Further, deposition and analysis of the proposed 2D materials is necessary to assess their potential in novel electronics and optoelectronics. The specific purposes and aims of the proposed project are as follows:

- Study and characterize the influence of the energetic particle bombardment associated with sputter deposition onto the proposed 2D-materials.
- Develop a sputter deposition process that enables deposition onto the proposed 2D-materials without deteriorating their quality.
- Develop a sputter deposition process that enables deposition of high quality layered sulphide films, such as WS₂, MoS₂, SnS₂, and novel combinations thereof
- Characterize the sputtered 2D-materials films and evaluate them from a fundamental standpoint, e.g. correlation of the structural aspects (crystal structure and defects) with the fundamental electronic properties.

Consortium

Tomas Nyberg – Uppsala University – Sweden – Funded by: VR/VINNOVA (Coordinator)

Alexander Foehlich – Institute for Methods and Instrumentation in Synchrotron Radiation Research –
Germany – Funded by: DFG

Nadine Witkowski – INSTITUT DES NANOSCIENCES DE PARIS – France – Funded by: ANR