

2026-2027 Internship proposal at LMGP & CEA-Leti

Synthesis of vanadium sulfide thin films on 1ML-MoS₂/thermal-SiO₂ substrates by Molecular Layer Deposition and *in situ* reactive annealing, for electrical contacts on 2D MoS₂-based devices

Context

As the silicon electronics approach their physical limits with a collapse of the channel mobility at the sub-10 nm scale, semiconducting transition metal dichalcogenides (s-TMDs) such as MoS₂ or WS₂ offer new perspectives for the **fabrication of low-power and ultimately downscaled transistors** (channel thickness down to 0.65 nm). However, contact engineering on such material is still challenging due to the high contact resistance obtained with most metals (Fermi level pinning), and damages that are created at the metal/s-TMD interface [OBR2023]. In this context, the use of semi-metallic transition metal dichalcogenides (m-TMDs) such as **vanadium disulfide (VS₂) represents an excellent option for the realization of low resistance (ohmic) Van der Waals contacts on semiconducting TMDs** [JI2017,ZHA2022,EFF2024].

Researchers at the Laboratoire des Matériaux et du Génie Physique (LMGP) and CEA-Leti recently demonstrated the synthesis of lamellar VS₂-like thin films on thermal SiO₂ wafer by using a two-step route comprising a molecular layer deposition step (MLD) followed by reactive thermal annealing. Then, the next step is to demonstrate the synthesis of VS₂-like thin films on 2D MoS₂, by the same synthesis approach.

Project description

The selected candidate (M2 intern) will synthesize ultrathin (less than 10 nm thick) VS_x films on 1ML MoS₂/100nm-thick-SiO₂/Si substrate obtained from CEA-Leti, and study the reactive thermal annealing step. This work will be carried out at LMGP with a dedicated reactor allowing *in situ* optical (ellipsometry) and chemical characterization (residual gas analysis) during the synthesis. She/he will investigate the chemical composition and structural properties of the film after growth using quasi *in situ* X-ray photoelectron spectroscopy at CEA-Leti, and the electrical properties of the VS_x/MoS₂ thin heterostructure using four-points probe electrical measurements. She/he will also actively participate in an campaign of experiments at the Synchrotron SOLEIL (Saint Aubin, France) which is very likely to take place by the end of June 2026 [CIA2019,ABI2022]. To date, the synthesis with LMGP's equipment demonstrate reproducible, homogenous, 5-10 nm-thick VS₂-like thin films grown on thermal 100nm-thick SiO₂/Si substrates, with a resistivity as low as 1000-2000 μΩ·cm at room temperature.

References: [OBR2023] Nat Commun (2023) 14, 6400. 10.1038/s41467-023-41779-5 ; [JI2017] Nano Letters (2017) 17, 4908. 10.1021/acs.nanolett.7b01914 ; [ZHA2022] Adv. Funct. Mater. (2022) 32, 2204760. DOI: 10.1002/adfm.202204760 ; [EFF2024] ACS Nano (2024). 10.1021/acsnano.3c05907 ; [CIA2019] J. Synchrotron Rad. (2019). 26, 1374. DOI: 10.1107/S1600577519003722; [ABI2022] Chem. Mater. (2022), 34, 24, 10885. DOI: 10.1021/acs.chemmater.2c02369]

Scientific environment:

The master candidate will collaborate with a PhD student and a CEA-Leti apprentice at the LMGP (Materials Science and Physical Engineering, team Synfoni) and researchers at CEA-Leti. Located in the heart of an exceptional scientific environment, the LMGP and CEA-Leti offer to the applicant a rewarding place to work. The framework of our internship proposal is set by the ANR project SIN-2D (Smart Integration of 2D semiconductors, ANR-25-CE09-7993) and a PhD support financed by the Labex Microelectronics (μElec LabEx). The ANR SIN-2D consortium includes Grenoble INP-UGA/LMGP, CEA-Leti and SOLEIL synchrotron.

Profile & requested skills:

The candidate must be engaged in a research master program in physics, chemistry or material science or closely related sciences. She/he should also have ability and initiative to get to the heart of the problem and bring it to completion; good communication, organizational and scientific skills are required.

Allowance: Internship allowance will be provided (~600 € / month)

Start date: February 2027

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