2025-2026 Internship proposal at LMGP & CEA-Leti

Vanadium sulfides (VS_x) ultra-thin films synthesized by a hybrid Atomic/Molecular Layer Deposition and thermal annealing, on 2D-MoS_2/SiO_2 substrates.

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 MoS_2 or WS_2 offer new perspectives for the **fabrication of low-power and ultimately downscaled transistors** (channel thickness down to 0.65 nm) due to their excellent electrostatic control and immunity to short-channel effects. 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 (VS_2) represents an excellent option for the realization of low resistance (ohmic) Van der Waals contacts on semiconducting TMDs** [QUIN2017,ZHA2022].

Researchers at CEA-Leti recently demonstrated the proof of concept of a VSx/MoS_2 stack using a hybrid atomic layer deposition/molecular layer deposition synthesis route. However, the complexity of the vanadium-sulfur phase diagram and the limited stability of the as-deposited vanadium sulfide thin film requires a dedicated study in order to find the right balance between **(1)** - contact resistance at the VSx/MoS_2 interface, **(2)** - resistivity, work function and atmospheric stability of the VSx contact, and **(3)** - p-type doping induced by vanadium diffusion into the MoS_2 channel.

Project description

The selected candidate (intern) will grow ultrathin (less than 10 nm thick) VS_x films by Atomic Layer Deposition/Molecular Layer Deposition on MoS_2/100 nm thick SiO_2/Si substrate. This will be done in a dedicated reactor that allows *in situ* optical (ellipsometry) and chemical characterisation (residual gas analysis) during the ALD/MLD and the subsequent thermal annealing steps. She/he will investigate the chemical composition, structural and electrical properties of the film after growth using techniques such as X-ray photoelectron spectroscopy and Raman scattering at CEA-Leti. She/he will investigate the electrical properties of the VS_x/MoS_2 thin heterostructure. She/he will also actively participate in an experimental campaign at the Synchrotron SOLEIL (in 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, 10 nm thick amorphous-VS_x thin films grown on thermal 100nm-thick SiO_2/Si substrates, with a resistivity in the range of 1000-2000 µΩ·cm at room temperature

References: **[OBR2023]** Nat Commun (2023) 14, 6400. DOI: 10.1038/s41467-023-41779-5 ; **[QIN2017]** Nano Letters (2017) 17, 4908. DOI: 10.1021/acs.nanolett.7b01914 ; **[ZHA2022]** Adv. Funct. Mater. (2022) 32, 2204760. DOI: 10.1002/adfm.202204760 ; **[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 at the LMGP (Materials Science and Physical Engineering, team Synfoni) and researchers at CEA-Leti. Located in the heart of an exceptional scientific environment (access to the CMTC and PFNC platforms and CEA-Leti's clean room), 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 center.

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 (567 € / month)

Start date: February 2026

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