

Internship offer (M2) :

Levitation-assisted synthesis of transition metal carbide (TMC) thin films

Keywords: CVD, magnetic levitation, Liquid-Metal Catalyst

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This project aims at synthesizing transition metal carbides (TMC) as thin films. These materials, also referred to as MXene when they are strictly two-dimensional, are gaining a lot of attention thanks to their electronic, optical, and magnetic properties, opening the path to electrochemical storage, sensing, and superconductivity applications¹. While these materials are mostly obtained through selective chemical etching of the "A" element from MAX phases², it was recently demonstrated that Chemical Vapour Deposition (CVD) also allows for the synthesis of MXenes such as Mo₂C, WC, and Ti₂C, among others³. Recent progress has been made by using a liquid metal catalyst, typically molten copper. Solid catalysts suffer from parasitic nucleation at grain boundaries, whereas a liquid surface can host smooth, defect-free deposition of the material. This project aims at taking advantage of SIMaP-EPM's expertise in magnetic levitation by using a levitated molten metal as a substrate (or catalyst)⁴. This enables a crucible-free reactor design, avoiding the contamination issues inherent to traditional crucibles, which may pollute the liquid catalyst and affect nucleation of the deposited material.

The student will be in charge of:

- sample preparation.
- experimental parameter tuning (precursor pressure, temperature, chemical nature of the substrate).
- initial characterization (e.g., SEM/TEM, or other techniques depending on the deposition)
- As a secondary objective, further work will be carried out using an already-developed instrumented reactor, allowing direct visualization of the deposited material through optical microscopy and/or in situ Raman spectroscopy.

Location : SIMAP-EPM, Grenoble campus, 1340 rue de la piscine, 38402 Saint-Martin d'Hères France

Duration and remuneration: up to 6 months, February-august or less, ~600 €/month

Student profile :

- Master / Engineer Student in Material Science or other relevant field (M2 level)
- Interest in CVD, experimental developments and material characterization
- Curious, organized, autonomous.

- (1) *2D metal carbides and nitrides (MXenes) for energy storage* | *Nature Reviews Materials*.
<https://www.nature.com/articles/natrevmats201698> (accessed 2026-09-17)
- (2) *Two-Dimensional Nanocrystals Produced by Exfoliation of Ti₃AlC₂* - Naguib - 2011 - *Advanced Materials* - Wiley Online Library. <https://advanced.onlinelibrary.wiley.com/doi/10.1002/adma.201102306> (accessed 2026-09-17)
- (3) Tsakonas, C.; Dimitropoulos, M.; Manikas, A. C.; Galotis, C. Growth and in Situ Characterization of 2D Materials by Chemical Vapour Deposition on Liquid Metal Catalysts: A Review. *Nanoscale* **2021**, *13* (6), 3346–3373.
<https://doi.org/10.1039/d0nr07330j>
- (4) Pons, R.; El Bakali, A.; Chaussende, D.; Chometon, P.; Budenkova, O. Electromagnetic Levitation of Liquid Metal Droplets under a Horizontal DC Magnetic Field. *J. Phys. D: Appl. Phys.* **2025**, *59* (1), 015309.
<https://doi.org/10.1088/1361-6463/ae27db>