COLLOIDAL SYNTHESIS AND PHASE TRANSITION OF MONOLAYER HETEROSTRUCTURES.

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : Laoratoire Chimie ENS

LEVEL : M2
TEAM(S) : LUMINESCENCE

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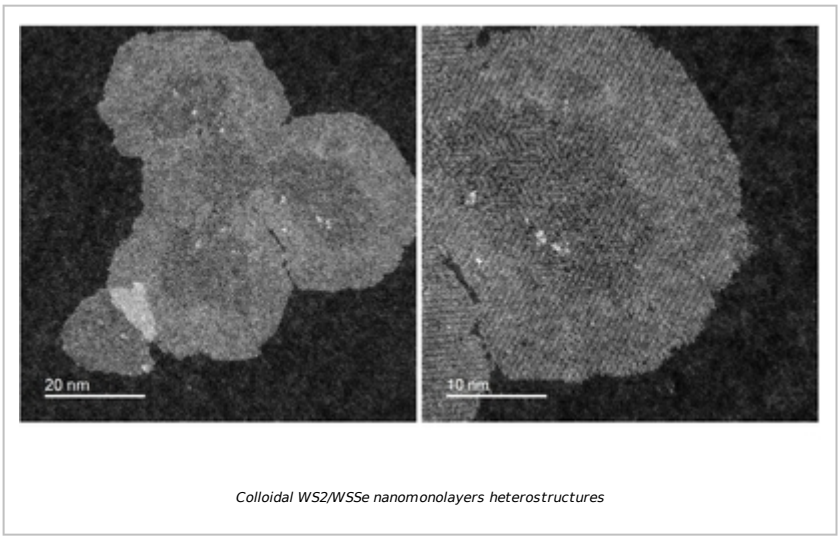
KEYWORD(S) : monolayer / cristal structure / electron microscopy

SCIENTIFIC CONTEXT :

Group IV transition metal dichalcogenide (TMD) monolayers have garnered significant attention due to their exceptional optoelectronic properties, arising from their stable hexagonal (1H phase) crystal structure. However, alternative crystal phases, such as the metastable 1T' phase, where metal atoms exhibit octahedral coordination, are emerging as a promising research area. These unconventional phases display intriguing properties like metallicity, semi-metallicity, superconductivity, and catalytic potential.[1] Despite their promise, current synthetic methods for these monolayers are limited.



Colloidal WS2/WSSe nanomonolayers heterostructures

The project aims to explore these unconventional TMD polymorphs through colloidal synthesis and study their phase transition behavior. The expected outcomes of the project include the discovery of these new phases as well as their phase stability, paving the way for novel functional nanomaterials.

MISSIONS :

During the project, the intern will pursue in parallel two objectives: the synthetic development of colloidal monolayers in their metastable phase and the study of their phase transition behavior.

The student will explore first a new lateral heterostructure scheme we recently devised (see figure) to produce core/crown monolayers combining size-controlled monolayers core [2], with an alloyed crown [3].

In parallel he/she will systematically characterize the monolayers from routine phase identification using UV-Vis spectroscopy and X-ray diffraction to HRSTEM using the St Etienne Jeol NeoARM microscope. Phase transition behavior will be monitored in-situ using Raman spectroscopy and XPS in collaboration with Debora Pierrucci at INSP.

At the Light and Matter institute, the student will work in the Luminescence team, at the interface between colloidal synthesis, structural characterizations and optical properties. This internship take place in the framework of the ANR project PhaseCraft in collaboration with theory and advanced characterization groups and can be continued during a PhD.

OUTLOOKS :

Possibility to continue as PhD in the framework of the ANR PhaseCraft.

BIBLIOGRAPHY :

[1] Sokolikova, M. S. & Mattevi, C. Chem. Soc. Rev. 49, 3952–3980 (2020).

[2] Shahmanesh, A. et al. ChemRxiv (2023) doi:10.26434/chemrxiv-2023-tnggx.

[3] Shahmanesh, A. et al. J. Phys. Chem. C 125, 11058–11065 (2021).

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