CREATING FLUORESCENT TMD/HBN NANOCOMPOSITES FOR LIGHTING APPLICATIONS

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : LMI Catherine Journet

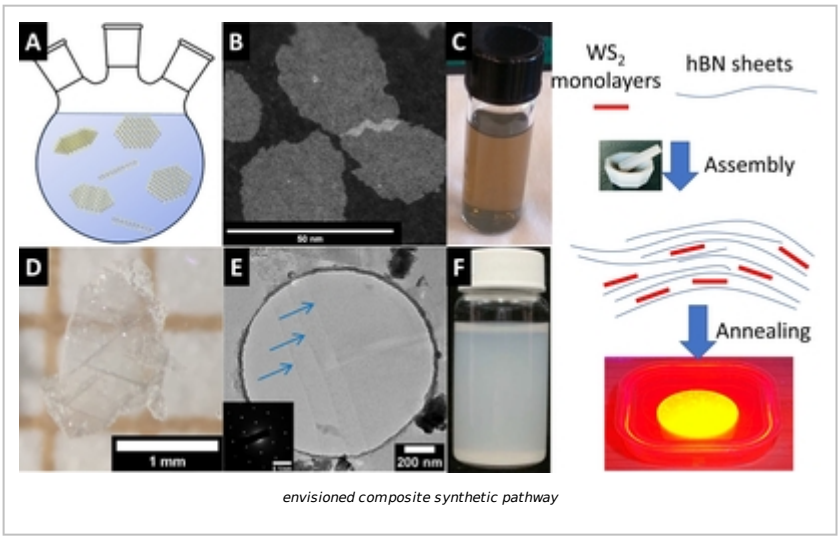
LEVEL : M2
TEAM(S) : LUMINESCENCE

CONTACT(S) : MAHLER Benoit

CONTACT(S) DETAILS: benoit.mahler[at]univ-lyon1.fr / Tel. 0472431130

KEYWORD(S) : colloidal synthesis / monolayers / luminescence

SCIENTIFIC CONTEXT :



envisioned composite synthetic pathway

Modern lighting technologies mainly rely on blue LEDs combined with a down-converting phosphor, producing white light by mixing the blue LED emission with the yellow emission from the phosphor. The most common phosphor, YAG:Ce, lacks red emission. To compensate, additional red-emitting materials are used, typically rare-earth doped compounds (Eu^{3+}) or quantum dots containing either scarce (indium) or toxic (cadmium) elements. A promising alternative is now emerging from the field of two-dimensional (2D) materials. Transition metal dichalcogenide (TMD) monolayers, based on tungsten or molybdenum, can act as highly efficient light emitters with fluorescence quantum yields approaching unity. These compounds are free of toxic heavy metals, and their strong light absorption means that only minute amounts of material are required (for instance, a single MoS_2 monolayer absorbs ~10% of incident blue light). However, the luminescence of TMD monolayers is extremely sensitive to the local environment. Encapsulation between hexagonal boron nitride (hBN) layers is currently the most effective way to stabilize and enhance their emission.

The goal of this internship is to explore the fabrication of composite fluorescent materials by assembling colloidally synthesized TMD nanomonolayers with exfoliated hBN sheets. The approach combines colloidal synthesis, liquid-phase exfoliation, assembly, and controlled annealing to obtain stable, highly luminescent composites.

MISSIONS :

Concretely, WS_2 nanomonolayers will be synthesized in solution (A), characterized using high-resolution scanning transmission electron microscopy (HRSTEM, B), and stored as stable dispersions(C). In parallel, hBN crystals will be synthesized at high temperature (D) and exfoliated into few-layer sheets (E), also forming stable dispersions (F). The two components will then be combined via a drying/grinding procedure (scheme), followed by annealing to remove organic residues, trigger possible TMD phase transitions, and improve interfacial contact.

The intern will synthesize WS_2 nanomonolayers, exfoliate hBN into few-layer sheets, assemble the two components into composite materials and optimize annealing conditions to maximize luminescence.

After the composite synthesis he/she will characterize the composites structurally (TEM, SEM, PXRD) and optically (luminescence spectroscopy), in order to establish the link between structure and optical properties.

This project will provide the student with a complete training in nanomaterials synthesis, assembly, and advanced characterization techniques, in the context of next-generation lighting applications.

OUTLOOKS :

x

published on 29/10/2025