INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Laboratoire de Physique des Solides
CNRS identification code: 8502
Internship director'surname: Erwan Paineau
e-mail: erwan-nicolas.paineau@universite-paris-saclay.fr Phone number:+33169156051
Web page: https://equipes.lps.u-psud.fr/matrix/
Internship location: Laboratoire de Physique des Solides & synchrotron SOLEIL

Thesis possibility after internship: YES
Funding: NO (grants are currently requested) If YES, which type of funding:

Morphology control of boehmite nanoparticles and impact on phase transition upon thermal annealing

Boehmite (γ-AlOOH) is an important raw material in industry, for catalytic applications or polymer nanocomposites, among others [1,2], as it serves as precursor for the production of alumina (Al_2O_3) phases through calcination. It is well known that the transformation of boehmite into alumina involves a series of phase transitions ($\gamma \rightarrow \delta \rightarrow \theta \rightarrow \alpha$) [3] but little systematic attention has been paid to the effect of the morphology on the thermal transformation of boehmite. Boehmite can adopt different morphologies depending on synthesis conditions (e.g., nature of the precursors, pH, temperature, aging step) [4]. Rhombic-shaped plates are typically obtained in basic conditions while acidic conditions favor the formation of various elongated boehmite nanoparticles by simply changing the anion species (ClO_4^-, NO_3^- or Cl^-) or the ratio of precursors.

This internship project aims to explore the impact of boehmite morphology on phase transition to γ-Al_2O_3 upon thermal annealing. The first objective will be to determine the parameters controlling size and morphology of boehmite nanoparticles synthesized under hydrothermal conditions in presence of urea (nature of the anions, ratio of precursors, synthesis temperature and duration). These data will be used to determine the most relevant physicochemical parameters that influence the morphology of boehmite. The second objective will concern the investigation of the role of the initial morphology on phase transitions upon thermal annealing on a selection of samples with the most contrasting morphologies. The characterization of the samples prior and after calcination ranging from RT to 1200°C will be realized using a combination of experimental techniques, including infrared and Raman spectroscopies, X-ray diffraction, and electron microscopy. These measurements will be completed by simulations of the diffraction patterns using specific home-made programs. The possibility of conducting in situ X-ray absorption near edge spectroscopy experiments (LUCIA beamline) at the Soleil synchrotron could complement the laboratory measurements, pending the allocation of beamtime. This will provide insight into the transformation process of the atomic environment of aluminum (conversion of octahedral to tetrahedral sites) depending on the type of boehmite.

The student selected will participate in the acquisition and processing of data obtained through advanced crystallochemistry techniques. She/he will benefit from collaboration with colleagues at LPS who have complementary expertise, as well as with scientists from the LUCIA beamline. The internship will last 6 months and may be followed by a PhD thesis.

References:

[1] Amrute et al., Science (2019), 366, 485-489; [2] Yang et al., Chem. Soc. Rev. (2024), 53, 5014
[3] Sudheer et al., ChemCatChem (2024), 16, e202400677; [4] Valette et al., J. Phys. Chem. C (2021), 125, 26049-26060; [5] Pan et al., Appl. Clay Sci. (2026), 287, 108209

Condensed Matter Physics:	YES	Soft Matter and Biological Physics:	NO
Quantum Physics:	NO	Theoretical Physics:	NO