

Sequestration of phosphates by novel LDH based membranes – Study of the dynamic of adsorption and release by XRD and SSNMR.

Context

P-PO₄ is mainly used for agriculture and animal feed additives (82% as fertilizers, 7% as food production, 8% as industrial P and 3% as P4 derivatives). Economic development and growing demand on Phosphate over the world, strongly impacts their natural stocks and imposes to change for economic developments based on sustainable re-use/recycle/recover/reprocess actions from waste (circular economy concept). Phosphate is considered by EU as a critical raw materials (CRM) because of its scarcity (peak of production; 160 Mtons produced per year over 16000 Mtons estimated reserves in about 100 years). Moreover, regulations have strengthen environmental policies to protect the environment from the adverse effects of urban waste water discharges by recovering nutrients. Then optimization of the P-PO₄ efficient uses, reduction of P waste, reduction of P-PO₄ pollution, and development of novel strategies for reuse and reprocess Phosphate sources are a major targeted societal challenge nowadays. New technologies and practices for sustainable use of Phosphate are needed for a P long-term availability. Recovery of P and P-PO₄ from liquid and solid wastes needs innovative processes adapted to human P-uses, local and diffuse dissemination, small and large waste volumes to be treated and development of small or large scale recovery process plants.

Objectives

This research project is part of the Danish-French project RecoverP that aims to develop new strategy to recover Phosphate from wastewaters in wastewater treatment plants (WWTP). In this project we will target the elaboration of novel solid membranes based on Layered Double Hydroxides (LDH) with efficient reversible or irreversible sequestration properties for Phosphates (H₂PO₄⁻/HPO₄²⁻/PO₄³⁻, P₂O₇⁴⁻, polyphosphates, Organo-Phosphates). Membranes with high surface and porosity will be designed and characterized. Kinetic and thermodynamic of Phosphate adsorptions by the prepared LDH membranes will be investigated. Dynamic of adsorption will be studied by X-ray Diffraction in-situ analysis and solid state ¹H, ³¹P, ²⁷Al NMR to better understand the mechanism of Phosphate/LDH interactions.

Scientific detailed program

1. Elaboration of LDH and nanocomposite LDH membranes
2. Structural and textural characterizations
3. Kinetic and thermodynamic studies of phosphate adsorption
4. Structural characterization of the P-PO₄ sequestration dynamic by XRD and SSNMR

Candidate

MSc student with a scientific knowledge and expertise in chemistry and physics of materials. The student will experiment synthesis of LDH and realize a large panel of chemical analysis and solid state characterizations focused on Phosphate/LDH sequestrations. SSNMR will be performed @SDU.

Supervisors

C. Forano (Prof. UBP) & U. Gro Nielsen (Prof. SDU) for the NMR experiments @ South Denmark University (SDU - Odense – Denmark).

Place

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