Synthesis of catalysts based on iron-rich hybrid talc-like lamellar materials for application in advanced oxidation processes

Hosting institution: Research team "Transfers, Reactivity, Materials for Clean Processes" of the Institute of Material Science of Mulhouse (France)
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Context: The accumulation of persistent organic pollutants in the environment poses a major threat to human health and the environment. An effective method of their elimination is the use of advanced oxidation processes (AOPs) involving the generation of hydroxyl radicals known to be strong oxidizers. Among the AOPs, the processes derived from the Fenton reaction involve the reaction between ferrous ions and hydrogen peroxide. In order to apply this type of process in heterogeneous catalysis, the solid supports containing iron can be made. In addition, hydroxyl radicals can be directly generated in situ by the electrochemical reduction of dissolved oxygen. This approach allows to combine the ability of the conductive support (carbon) to produce the hydrogen peroxide with that of the iron (II) to oxidize organic molecules. The functionalization of the carbon supports can be done by incorporating iron ions, clusters or oxides constituting the active sites for the oxidation. Although these materials are functional, they are prone to release Fe3 + in the solution, leading to the loss of the catalytic activity of the functionalized material. In addition, it leads to the reduction of the electrical conductivity of the functional material and therefore of its efficiency. Thus, the design of new composite materials is essential to these eliminate drawbacks.

Objectives: This research project aims to study the catalytic properties of iron-containing lamellar compounds in an electro-Fenton process for the degradation of persistent organic pollutants. The feasibility of this concept has been demonstrated[1], but the development of this innovative approach requires a thorough understanding of the structure of the conductive composite material, its evolution during the oxidation process, as well as the characterization of degradation products. Thus, the thesis work will be composed of 3 parts:

i. Synthesis and characterization of composite materials,
ii. Study of the catalytic degradation of diatrizoate by the electro-Fenton process and the analysis of degradation products,
iii. Characterization of the composite material and its surface after the catalytic tests.

Means: The project will be carried out in collaboration between the research team "Transfer, Reactivity and Materials for Clean Processes" of the Institute of Materials Science of Mulhouse (IS2M) and the research team "Chemistry and Process Engineering" from the Institute of Chemical Sciences of Rennes (ICSR), Abdeltif Amrane, Florence Fourcade and Isabelle Soutrel. The PhD student will learn the synthesis of composite materials and their characterization by techniques such as DRX, MEB, XRF and XPS at IS2M and carry out

[1] S. M. Mirona, J. Brendlé, L. Josien, F. Fourcade, F. Rojas, A. Amrane, L. Limousy. Comptes Rendus de Chimie (2019). *accepted*

oxidation tests with the functionalized electrodes, as well as the identification of degradation products during electrolysis at ICSR.

Profile of the candidate: We are looking for a candidate with good academic level to enter the competition of the Doctoral School of Physics and Physical Chemistry (ED182). Interested candidates are requested to contact us until 8 April 2019 and submit a single pdf file containing a cover letter, CV and transcript of records.

Keywords: lamellar compounds, synthesis of composite materials, catalysis, depollution, advanced oxidation processes, electro-Fenton