Catalytic localism in layer-by-layer composite films for light-driven water treatment

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Summary:

Water treatment is a priority health issue that scientists must address. In particular, in hospitals and the care sector, wastewater is polluted by medical products (antibiotics, anti-cancerous, anti-inflammatory or contraceptive drugs). Impact on the world's population health is dramatic at short- and long-term, with eg. higher cancer risks and reduction of the human reproductive capacity, as treatments in place to date are not efficient enough.[1] The development of novel sustainable cost-effective water treatment technologies is thus necessary.[2] In this context, H_2O_2-driven photo-Catalytic Wet Peroxide Oxidation (CWPO) catalysis is a high-prospect advanced oxidation process operating under solar light for mineralizing those refractory compounds in water at room-temperature. Albeit very active, and although H_2O_2 is a green oxidant, producing only H_2O and O_2 as end-products, this catalysis still faces a limited perspective for technological deployment, that results from the use of costly and non-sustainably produced H_2O_2 instead of O_2 as oxidant.

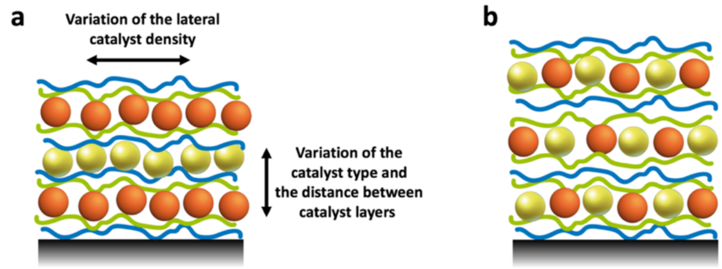

Figure. *Schematic representation of idealized catalyst-based LbL-assemblies.*

The aim of this master work, which is part of the CATLOC HiFunMat project, is to contribute to the development of a novel multi-functional catalysts for solar light-driven water treatment, by applying a strategy of catalytic (chemical) localism. This new concept proposes to combine two catalysts working in synergy under solar-light, the first one producing H_2O_2 from molecular water and O_2, and the second one using H_2O_2 for degrading the pollutants. To do so, we will rely on the bottom-up layer-by-layer self-assembly[3] to precisely control the spatial positioning of both catalysts and the resulting properties of the multilayer catalysts.[4] The novelty here relies on the replacement of organic polyelectrolytes by inorganic polyelectrolytes, namely polyoxometalates, to improve the stability of films against self-oxidation issues, induced by the production of highly active oxidative radicals within the layers. The use of different building blocks (catalysts, polyelectrolytes), deposition methods and deposition conditions will allow exploring various assembly structures and determining those leading to the most relevant properties for our application. This work will be carried out in collaboration with ICPEES and BIOMAT labs.

References:

[1] C. Baines *et al. Environ. Int.* **2021**, *149*, 106391.
[2] D. B. Miklos *et al.* Water Res. **2018**, *139*, 118.
[3] G. Decher *Science* **1997**, *277,* 1232; Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, 2nd Edition (Eds: Decher, G. and Schlenoff, J. B.), Wiley-VCH: Weinheim, 2012.
[4] D. Dontsova *et al. Macromol. Rapid Commun* **2011**, *32*, 1145 ; L. Truong-Phuoc *et al. ACS Appl. Mater Interfaces* **2016**, *8*, 34438 ; M. Motay *et al. ACS Appl. Mater Interfaces* **2020**, *12*, 55766.

Requirements & Application:

We are looking for a highly motivated master student having a formation in chemistry, physical chemistry, materials science, nanoscience and preferably with skills and/or interests in the following areas: materials, physical chemistry, thin layers, catalysis and surfaces.
Please address your application (CV, motivation letter, copy of recent grades) to Olivier Félix [olivier.felix@ics-cnrs.unistra.fr].

This proposal can be sent to students abroad.