New inorganic transition metal phosphates catalysts for selective production of lignin derived C9-monomers.
Vers la découverte de nouveaux catalyseurs à base phosphates de métaux de transition en vue de la transformation de la lignine en dérivés C9 des monolignols.

Introduction:

The catalytic conversion of biomass into liquid biofuel and high added-value chemicals becomes highly strategic in order to shift our way of life from the extensive use of fossil fuel into more ecofriendly and sustainable bioresources allowing a virtue closing of the carbon cycle. Lignin polymer represents one of the constituents of lignocellulosic biomass and is considered as one of the major available resources for which valorization at industrial scale is still needed. To reach that, currently different processes were studied such as fast pyrolysis, hydrolysis, oxidative depolymerization and hydrogenolysis. This latter is considered as the most promising method for efficient and selective cleavage of C-O bonds. Nevertheless, due to drastic reaction conditions it often led to the formation of non-functional aromatics limiting applications to fuels. Nickel based catalysts were reported in the literature as one of the non-noble based materials able to offer selective C-O cleavage, preventing over hydrogenolysis/hydrogenation so that functional aromatics could be obtained. Additionally, costs linked to their synthesis and use remain low compared to classical noble metals based catalysts commonly employed.[1] Among this class of catalysts, it appears that the use of Inorganic based phosphates as catalysts support offers many advantages: easy way of synthesis, high stability under the aqueous reaction conditions, and versatility through easy control of acid/base and hydrogenation properties.[2-3] Tuning finely these properties will offer a way to control the selectivity of the reaction.

In the present PhD proposal (figure 1), we aim to synthesize, to characterize and test their catalytic ability to depolymerize lignin into value monomer chemicals as C9-units. For catalyst design, different strategies could be followed. The first consist in exploring the use of highly stable materials as $LnPO_4 \cdot nH_2O$ (Ln = lanthanides)), $Ca_5(PO_4)_3X$ (X = F, OH, Cl) or $Na_2M^{IV}(PO_4)_2$ (M = …) as host matrices for the deposition of 3d metals able to act as active sites for Lignin hydrogenolysis. In a second time the goal will be to explore the formation of new compounds having transition elements by doping identified phosphate host matrices or synthesizing new phosphate compounds containing nickel, copper or other 3d elements in their structure and the evaluation also of their stability under working conditions and the ability the cleave C-O bonds. All catalysts will be applied to the depolymerization of technical lignin either isolated from black liquor by precipitation or extracted from various biomasses by short time cooking or Organosolv method. Noticeably, the catalytic tests will be performed under mild reaction conditions, typically applying reaction temperature below 100°C, and hydrogen pressure less than 20 bar.

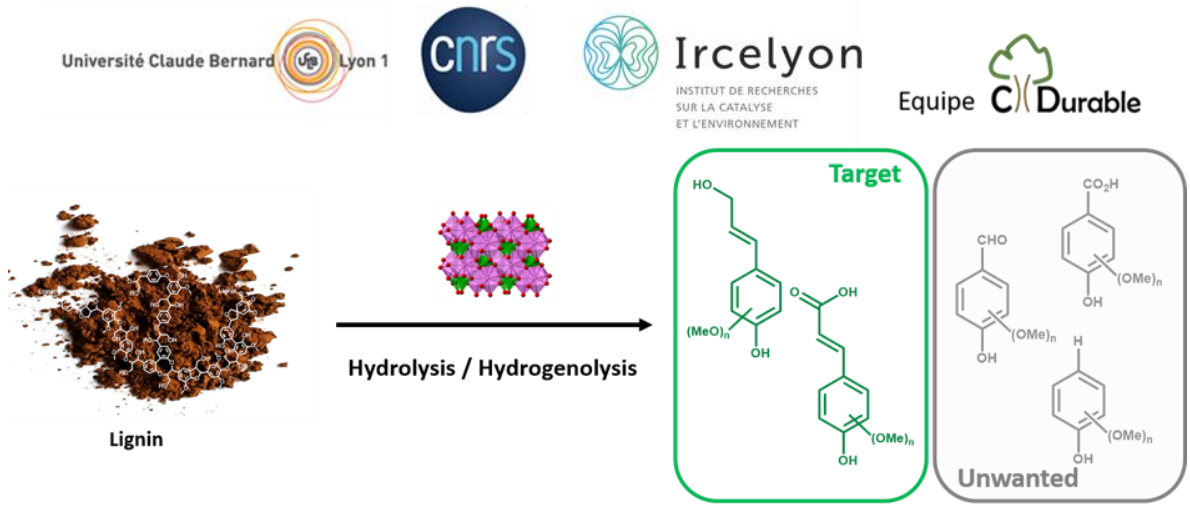

Figure 1. General approach of the PhD project

The obtained materials and products will be fully characterized by a variety of techniques available at IRCELYON such as PXRD, SEM, TEM, BET, NMR.

Candidate: The PhD student will have to possess strong background in synthesis and structure characterization of new materials (inorganic, organic-inorganic) using different techniques available at IRCELYON such as XRD (powder and single crystal), SEM, NMR. In addition, the candidate has to show high interests to the topics related to the field of conversion of biomass. Good marks and english speaking skills will be appreciated by the university selection committee.

Good organization and communication skills will be highly appreciated

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References:

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