'Physique et Chimie des Matériaux' – ED 397 – année 2020

PhD project for funding (max 1p), to send to

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Research unit (full name + acronym) : Laboratoire de Réactivité de de Surface (LRS)
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Number of phD under supervision : 1 Participation to supervisor training? no Year
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Research unit : LRS International co-supervision ? No
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Keyword 1 : catalysis Keyword 2 : zeolite
Keyword 3 : acido-basicity Keyword 4 : nanocomposites
Select co-funding programme if applicable : select

Project title : zeolite@basic-oxides core-shell nanocomposites as catalysts for tandem acid-base reactions

Project Description (~4000 characters, font 11 min):

The synthesis of complex organic molecules usually requires several successive catalytic steps and, between them, intermediate isolation and purification steps. Performing all these catalytic steps in a single reactor (so-called one-pot multi-steps catalysis) is highly desirable because it is simpler, more cost-effective and more environmentally-benign (thanks to waste reduction) and can also lead to unexpected activity enhancement[1]. This usually requires the simultaneous presence of two or more catalysts in the reactor. Immobilisation of these catalysts on a support is often a major requirement, not only because it allows an easier recovery of the catalysts but also because a site isolation of the different catalysts is often necessary to avoid mutual quenching of the catalysts.This is specifically the case for acid-base bifunctional catalysis, that plays a key role in the synthesis of many fine chemicals [2]. Indeed, homogeneous acid and base are antagonist catalysts that would immediately neutralize each other, whereas anchoring these two catalysts on a solid support can prevent their neutralization by keeping them apart [3]. This can be achieved by grafting, on the same silica support, two silanes(R-Si(OEt)3), one bearing an amine group and the other a sulfonic acid group. However, such catalysts require tedious preparation and often suffer from deactivation or active site leaching.

The objective of the present project will be to design “all-inorganic” acid-core@basic-shell nanocomposites with different intimacies between the acid and basic domains. The core of the catalysts will be made of a zeolite nanoparticle and the shell of a basic oxide. This new type of catalyst will associate the good stability of inorganic materials with a high proximity of the acid & basic functions thanks to nano-scale intimacy of the two components. These catalysts will be tested as tandem acid-base bifunctional catalysts in order to investigate the effect of nature, ratio & intimacy between the acid and basic component on activity and selectivity.

We are looking for a candidate with a specialization in M2 oriented towards material chemistry and/or catalysis. A good laboratory experience in the characterization of materials will be appreciated.

References

[1] J. Xie, W. Zhuang, W. Zhang, N. Yan, Y. Zhou, J. Wang, ChemCatChem 2017, 9, 1076.
[2] S. Shylesh, W.R. Thiel, ChemCatChem. 3 (2011) 278–287. doi:10.1002/cctc.201000353.
[3] T.L. Lohr, T.J. Marks, Nat. Chem. 7 (2015) 477–482. doi:10.1038/nchem.2262.