CATALYTIC MATERIALS FOR BIOMASS-DERIVED SECONDARY RAW MATERIALS TRANSFORMATIONS

- RESEARCH ACTIVITY -

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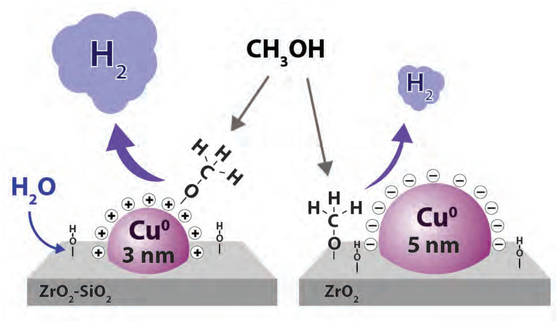
1. Sustainable Hydrogen Production

Different heterogeneous catalytic materials were developed for the sustainable hydrogen production from biomass-derived model molecules, with the general aim of eleminating, or at least reduce as much as possible, the content of noble metals.

A Ru/hydortalcite catalyst was prepared via a colloidal procedure and tested in the steam reforming reaction (SR) of acetic acid, a model molecul of the bio-oil. The well-formed and size-controlled Ru nanoparticles exhibited a remarkable stability and low coke deposition rates. The catalyti performances of such catalyst were totally comparable with those of a Rh-based catalyst, which is considered a benchmark for this reaction [9].

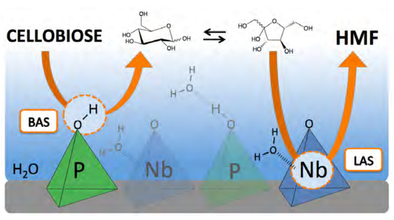
The addition of Mn as cheap promoter to a Pt/C catalyst was studied in the steam and aqueous phase reforming (APR) reactions of glycerol as abundant by-product of the bio-diesel industry. The presence of unsaturated and highly dispersed MnO_x sites promotes the SR reaction favoring the dehydrogenation, while in APR the Pt-Mn alloy stabilizes the promoter and increases the hydrogen selectivity [7].



An *all-in-one* catalytic site, in the form of small and highly electron-poor copper nanoparticles, was developed by adding a specific amount of silica in the zirconia support via a sol-gel technique. The hydrogen productivity of such catalyst is about four times higher than a conventional Cu/ZrO_2 catalyst and matches that of noble-metal containg catalysts.

2. FT-IR Characterization of Acidic Catalysts

The surface acidic properties of different catalytic materials were investigated using FT-IR spectrcopy and pyridine as probe molecule. With the aim of studying some materials resembling the working conditions, an innovative analysis protocol was developed and the pyrdine is contacted with the catalyst in aqueous solution.



The water-tolerant acidic properties of a series of niobia-phosphate catalyst was studied and correlated to the catalytic activity in the direct conversion in water of cellobiose to 5-ydroxymethylfurfural, a green platform molecule. It emerged that only a peculiar ratio of Lewis and Brønsted acid site could result in high catalytic activity. The smart balacing of such ratio is therfore to be preferred over increasing the total number of acid sites [4-8].

The amount and the ratio between Lewis and Brønsted acid site is crucial for many applications. For instance, a Pt (II) complex supported on montmorillonite was tested for the production on ethyl lactate from dihydroxyacetone and its acidic properties were investigated. In turned out that the Pt(II) is the catalytically active center in the form of a Lewis acid center capable to effectively coordinate the reactants [6]. The ratio between the two acid centers was found critical for the xylose–xylulose isomerization during the dehydration of xylose [3].

3. Photo-catalytic Degradation of Pollutants

Development of critical raw-material free photo-catalysts containing iron or titanium for the photo-degradation of organic pollutants. This work was carried out as a material supply contract with the Bracco Imaging SpA and was awarded the “Success Story” recognition by EIT Raw Materials.

Development of titania-gold hybrid nanostructure without surfactants. The synthesis is performed in flow and yields so-called gold nanostars coated with a thin layer (few nm) of amorphous titania which have shown photo-catalytic activity and will be assessed as bio-compatible matierials.

Pubblications

[1] Cat. Comm., 2019, In Press.
[2] ACS Appl. Energy Mater., 2019, In Press
[3] ChemSusChem, 2018, 11, 3649
[4] Mol. Catal., 2018, 458, 280
[5] Current. Catal., 2018, 7, 89
[6] J. Catal., 2017, 350, 133
[7] J. Catal., 2017, 349, 75
[8] Appl. Catal. B: Environ., 2016, 193, 93
[9] Appl. Catal. B: Environ., 2016, 181, 599
[10] Catal. Sci. Technol., 2016, 6, 3220

Acknowledgements

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