Développement de catalyseurs hétérogènes en présence d'un chauffage diélectrique et catalyse sous micro-ondes : Reformage d'hydrocarbures et de composés oxygénés

Development of heterogeneous catalysts using dielectric heating and catalysis under microwaves: Reforming of hydrocarbons and oxygenated compounds

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The use of hydrogen as an energy carrier is both a significant economical and environmental stake which lies in the search for renewable energies for the substitution of the energies of fossil origin. The process of reforming of hydrocarbons and oxygenated compounds aims at the production of hydrogen by catalytic way. It represents an alternative to the usually used process of combustion. The involved catalysts have to possess a sufficient activity in reforming as well as an excellent resistance against sintering in the presence of steam. Supported noble metals and mixed oxides are both families of usually used catalysts.

For several years, the synthesis under microwaves (MW) turned out to be one of the technologies the most adapted to the preparation of ceramic, superconductive and polymers materials. If the application of the microwaves in research laboratories developed in different sectors, it was less developed in the field of catalysts synthesis and much less in the field of heterogeneous catalysis (catalytic tests under microwaves). More particularly in the field of materials synthesis (inorganic compounds, pure oxides, mixed oxides or supported metals), number of works was performed. The obtained results showed very clearly the beneficial and spectacular effect of the microwaves on the physicochemical properties of the prepared solids, on their degree of cristallinity, on the nature of the phases, on morphology, on particles size and on dispersion (for supported metals). Besides with regard to conventional heating, in the presence of microwaves the temperatures of synthesis are appreciably lowered and the time of irradiation is extremely short which allows an economy of energy.

Description of the research project:

The research project contains two wings:

1/ Catalysts synthesis in the presence of dielectric heating (at atmospheric and medium pressures)

The program of research is centered on the synthesis of pure, unsubstituted and substituted metal oxides and supported metals based catalysts, with the aim of their use for reforming of hydrocarbons and oxygenated compounds in vapor phase. The objective is to develop stable catalysts for reforming and the settling of an original method for the preparation of active and selective catalysts having both low propensity to sintering and poisoning by carbon species deposition.

Dielectric heating (absence of temperature gradient, high speed of heating) will allow the preparation of nanoparticles of catalysts of which textural (specific surface area, geometry and pores distribution) or structural characteristics (nature of phases, as well as the degree of cristallinity) can be modulated. In particular, the use of microwaves will allow favoring the nucleation particles stage with regard to the growth stage, so improving the physicochemical properties of the solid obtained compared to conventional methods for which the control of these two processes is particularly difficult.

A comparative study with catalysts obtained by conventional methods will be made.

2/Catalysis under microwaves

The catalytic properties (solids prepared under microwaves irradiation and by conventional methods) for reforming of hydrocarbons and oxygenated compounds will be studied and connected with the physicochemical properties.

Additional catalytic activities measurements in drastic conditions will be performed in order to estimate both the resistance of catalysts to sintering (in the presence of steam) and to poisoning by carbon species. The understanding of the mechanisms of poisoning will allow optimizing the catalyst formulation so as to reduce catalyst sintering and carbon deposition or even to prevent them and so to maintain the catalytic activity. The nature and the stability of poisons species will be estimated by thermo-programmed methods and spectroscopy analyses.

In the case of supported metals, the support can play an important role in the process of poisoning. Several supports will be chosen according to their physicochemical properties and the catalysts will be studied.

Catalytic tests will be performed under microwaves irradiation and the results will be compared with those obtained in the presence of conventional heating

Profile of the candidate: Master degree or engineer having good knowledge in heterogeneous catalysis and physical chemistry