Développement de catalyseurs hétérogènes sous irradiation micro-ondes et catalyse en présence d'un chauffage diélectrique: Valorisation du méthane

Development of heterogeneous catalysts using microwaves irradiation and catalysis in the presence of dielectric heating: Valorisation of methane

Level : PhD

Profile of the candidate : Master degree M2 or Engineer having good knowledge in heterogeneous catalysis and physical chemistry.

Team(s) : ATARI

Contact(s) : akim.kaddouri@ircelyon.univ-lyon1.fr – Tel : + 33 4 72 44 84 76
thierry.caillot@ircelyon.univ-lyon1.fr – Tel : + 33 4 72 44 58 58

Keyword(s) : Microwaves irradiation / catalysts synthesis/ valorisation of methane

Scientific context : Development of new routes for the synthesis of solids is an integral aspect of materials chemistry. Some of the important reasons for this are the continuing need for fast and energy-efficient techniques, necessity to avoid competing reactions in processes. In recent times, several reports have appeared where conventional preparative techniques have been substituted by microwave methods. Dielectric heating is considered as a good alternative for carrying out many chemical or physical processes such as catalysts synthesis and catalytic heterogeneous reactions. This method is a very rapidly developing area of research. Besides, compared to conventional heating, the temperatures are appreciably lowered and the time of irradiation is extremely short which allows an economy of energy.

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 valorisation of methane by catalytic way aims at the production of products with high added value. The involved catalysts have to possess a high activity as well as an excellent resistance to poisoning and sintering. Heterogeneous catalysts such as supported noble metals or mixed oxides are generally used.

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 valorisation of methane. The objective is to develop stable catalysts 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) 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.

Missions : Catalysts synthesis, Physico-chemical characterisations, Catalytic testing

References :

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Application: Please send CV, motivation letter, copy of M1 and M2 grades, one or two recommendation letters including contact information **until May 20th, 2020.**