

# Rebirth of wasted agro-matters: new silica and carbon based nanomaterials prepared from rice husk as catalysts for the conversion of vegetable oil sludge to green fuels (biodiesel) and as adsorbents for the concentration of alcohols - BL/13/V11

## Context and objectives

Facing the important global warming, the exhaustion of crude materials and oil and the over-consumption of energy, new materials with advanced properties and new concepts in the recyclization of wasted by-products can be the driving force and the motor to find some issues of these important challenges of our modern society and human life.

Vietnam is well recognized as one of important agricultural countries with a huge production of rice and vegetable oil. With the introduction of new technologies and new agricultural methodologies, the agricultural production has received a great jump. However, this high production speed is also accompanied by the generation of a huge quantity of wastes and by-products. Although these agro-wastes can be used for the energy production by combustion, most part of these agro-wastes are not efficiently and economically used from the scientific point of view. Instead of being wasted, rice husk (rich in carbon and silica) and vegetable oil sludge could be the useful starting materials to create new silica and carbon based nanostructures and green fuels like diesel. The development of new preparation method to generate new nanomaterials and green fuels from rice husk and vegetable oil sludge, respectively, can not only resolve the serious environmental problem, but also to generate new nanomaterials and green fuels to render these wastes of agro-products useful.

The present project deals with the development of new chemical methods to prepare silica and carbon based nanostructures as catalysts and adsorbents and to produce green fuels (diesel) by using wasted agro-products such as rice husk and vegetable oil sludge as sources, respectively.

Through this joint scientific research project, a Belgo-Vietnamese network of excellence in the field of Nanomaterials, catalysis and purification for the realization of joint innovative scientific projects could be constructed.

## Methodology

This project focuses thus on three important aspects with the combination of the strong expertise in the preparation of nanomaterials of Belgian partner and those in the purification and catalysis of Viet Nameese partners. The recycle of wasted agro-matters to generate new nanomaterials and biofuels from rice husk and vegetable oil sludge is main objective. The prepared nanomaterials can be used as catalysts and adsorbents for the green diesel production and the concentration of alcohols. The project will have the following methodology:

- 1). Extraction of silica and carbon from the wasted agro-products such as rice husk by physico-chemical techniques;
- 2)Utilisation of the carbon and silica extracted from rice husk as starting chemical sources and precursors for the conception of new silica and carbon based nanomaterials;
- 3). Synthesis of nanomaterials directly from rice husk as silica and carbon precursors;
- 4). Modification and functionalization of these new nanostructures;
- 5). Application of these modified and functionalized nanostructures as catalysts for the conversion of another waste of agro-matters, vegetable oil sludge to green fuels (biodiesel) by thermal, pyrolysis and catalytic cracking reactions.
- 6). Application of these modified and functionalized as selective adsorbents for the concentration of alcohols.

## Results

### **WORKPACKAGE 1. Preparation of silica based and carbon based nanostructured materials from rice husks.**

1 kg rice husk from Vietnamese partner obtained from different regions containing a variable silica and carbon content was used. The chemical analysis of husk composition was realised. Different physical and chemical methods to extract silica and carbon from rice husk have been used and then the extracted silica was used as starting source to synthesize silica based nanostructures such as pure siliceous mesoporous materials. The synthesis was quite successful and highly organized mesoporous silica was obtained. On the basis of this success, the extracted silica containing small amount of carbon residues was used as starting silica source and other synthetic inorganic sources to synthesize silicoaluminate, metallosilicate mesoporous materials. The synthesis was also very successful. More importantly, for the first time, mesoporous zeolites HY, ZSM-5 and other zeolite structures were obtained. After an intensive characterization of these materials by TEM, SEM, N<sub>2</sub> adsorption, FTIR, solid state MAS NMR (<sup>29</sup>Si, <sup>27</sup>Al, ...), these materials have been used by Vietnamese partners as catalysts in the conversion of vegetable sludge oil and as adsorbents in the concentration of alcohols.

### **Workpackage 2. Application of these new nanostructures as catalysts for the conversion of another waste of agro-matters, vegetable oil sludge to green fuels (biodiesel) by thermal, pyrolysis and catalytic cracking reactions.**

Main characteristics of vegetable oil sludge as boiling point, heavy metal contents, iodine index ...etc have firstly been determined. A catalytic testing system (Microreactor) was constructed for evaluation of catalytic activity of new materials synthesized by Belgian partner. This microreactor can transform vegetable oil sludge to biodiesel. The first screening of the catalysts by microreactor and the characterization of used catalysts by a series of physico-chemical techniques have been made. The first results concerning the new materials as catalysts for the conversion of vegetable oil sludge is quite encouraging. The comparison made on mesoporous HY and mesoporous HZSM-5 zeolites showed that mesoporous ZSM-5 gave a better catalytic performance in term of conversion rate and selectivity to biodiesel.,

**WORKPACKAGE 3. Application of these new nanomaterials as selective adsorbents for the concentration of alcohols.**

Vietnamese partner produced alcohols from fermentation of rice, sugarcane and cassava (Vietnamese agro-products) by distillation. A purification system (Microreactor) was constructed and will be used in the concentration of alcohols. This part of work is still in progression.

## Products and services

**Two posters in the 6<sup>th</sup> International Mesostructured Materials Symposium, 7-12 Sept., 2008, Namur, Belgium**

**1) Synthesis, characterization and catalytic properties of HY and H-ZSM-5 zeolites by using silica resource from Vietnamese rice husk in the cracking reaction of vegetable oil sludge**

Le Thi Hoai Nam, Nguyen Dinh Tuyen, Nguyen Ngoc Triu, Tran Quang Vinh, Van Dinh Son Tho, Do Xuan Dong, Xiao- Yu Yang, Zoulika Hadj-Sadok and Bao-Lian Su

**2) Production of biofuel by cracking reaction of vegetable oil sludge over nao-meso ZSM-5 zeolite prepared from silica extracted from rice husk**

Le Thi Hoai Nam, Nguyen Thi Thanh Loan, Tran Quang Vinh, Xiao-Yu Yang and Bao-Lian Su

**Poster presented in ASEAN Workshop on Advanced materials science and technology, 15-21 Sept., 2008.**

**Influence of silica resource from rice husk on structure of the hzsm-5 zeolite**

Le Thi Hoai Nam, Nguyen Dinh Tuyen, Nguyen Thi Thanh Loan, Tran Quang Vinh, Do Xuan Dong, Le Thi Kim Lan, Nguyen The Anh, Le Quang Du, Vu Thi Minh Hong, Xiao-Yu Yang and Bao-Lian Su

**Manuscripts submitted to Journal of Materials Science, 2008**

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## Execution

**Period:** 01/11/2006-30/09/2009

**Laboratory/network**

**Belgium**

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## Discipline

Chemistry

Energy

Forest & natural vegetation

Agriculture Environment

Materials (bio- etc.)

Nanotechnology