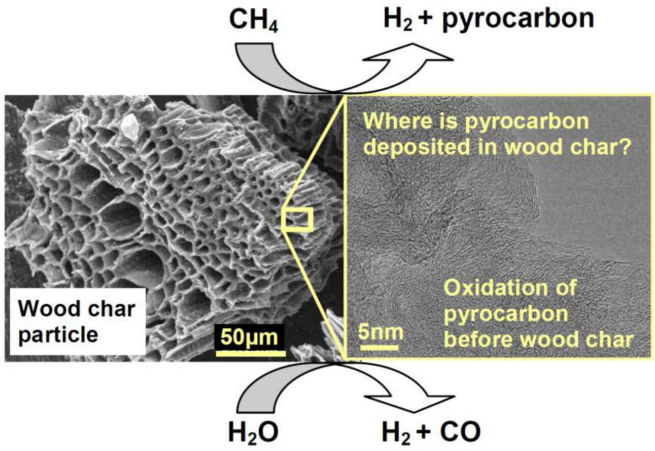
BIOCHAR AS A CATALYST FOR HYDROGEN PRODUCTION FROM METHANE CONVERSION

Anthony DUFOUR, CNRS, ENSIC, Nancy, France
Alain CELZARD, Univ. Lorraine, CNRS, IJL, Epinal, France
Vanessa FIERRO, Univ. Lorraine, CNRS, IJL, Epinal, France
François BROUST, CIRAD, Montpellier, France
Jean-Noël ROUZAUD, retired, previously CNRS, Normale Ulm, Paris, France
André ZOULALIAN, Univ. Lorraine, Nancy, France

Key Words: hydrogen, methane, activation, catalysis, active site.



During this talk, we will first introduce some potential synergies between methane and biomass, as 2 complementary energy vectors which could be converted in different process configurations.
Then, we will present how a simple char produced from wood pyrolysis could be a cheap and green catalyst to convert methane (and other hydrocarbons) into H_2 and a syngas [1-3].

First, the conversion of methane present in a pyrolysis gas was investigated for maximising hydrogen production from biomass gasification. The conversion of methane reached more than 70 %. Because steam and CO_2 were simultaneously present in the pyrolysis gas, the carbon catalyst was continuously regenerated. Hence the conversion of methane quickly stabilised. The oxidation of the char by CO_2 and H_2O prevented the blocking of the mouth of pores by the concurrent pyrolytic carbon (pyrocarbon) deposition. Under our high temperature, oxygenated functional surface groups were continuously formed (by steam and CO_2 oxidation) and thermally decomposed. The active sites for CH_4 chemisorption and decomposition were suggested to be the unsaturated carbon atoms generated by the evolution of the oxygenated functions at high temperature.

Without an oxidising gas, the conversion of methane led to apparent deactivation of the char by pyrocarbon deposition. The activity of the carbon bed and its available surface area were easily restored by subsequent H_2O gasification. The regeneration of the char and the reactivity of pyrocarbon were unraveled by various analytical techniques: temperature-programmed oxidation (TPO) in a calorimeter; High Resolution Transmission Electron Microscope (HRTEM), differential annealing of chars (at 1800°C) followed by XRD analysis, etc. The oxidation of pyrocarbon was faster than the oxidation of the weakly reactive mesoporous carbon in char as shown by the HRTEM analysis. Consequently, wood char is an effective, easy to regenerate, and cheap catalyst for converting hydrocarbons (CH_4 or tar) into syngas.

We will conclude this talk on the potential reactor configuration to promote char as a catalyst for syngas production.

[1] Applied Catalysis A: General 346 (1-2), 164-173
[2] Applied Catalysis A: General 360 (2), 120-125
[3] Applied Catalysis A: General 490, 170-180