CHARACTERIZATION AND CATALYTIC PERFORMANCES OF BIOCHARS SYNTHESIZED FROM A HYPERACCUMULATOR PLANT: ALYSSUM MURALE

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Phytoextraction or phytoremediation processes are motivated by the extent of soil contamination and the abilities of various plant to extract heavy metals from soil. Indeed, the valorisation of heavy-metal-polluted biomass (HMPB) is a key challenge. Pyrolysis is described as preferable technology for converting HMPB into bio-oil and biochar, which can be used as fuel, chemicals or materials. The economic feasibility of pyrolysis can be reached via the targeted production and utilization of high-value-added by-products (i.e. metal enriched biochar). Therefore, the migration and transformation of heavy metals during pyrolytic process must be understood to avoid further contamination (air, soil, water,…) and design applications (i.e. Adsorbent, Catalyst,…). In this presentation, we will describe the research according to the valorisation of a nickel hyperaccumulator plant (Alyssum murale, now called Odontarrhena chalcidica) as part of HY-C-GREEN project funded by FEDER and Region Grand-Est (France) with an interdisciplinary approach to develop a novel biorefinery concept for producing green materials and decarbonized hydrogen. Among the possible applications for the valorisation of this biomass, we studied its conversion to biochars in order to obtain fully bio-sourced catalysts, which could be used for hydrocarbon cracking/reforming in hydrogen synthesis processes. In this study, the fate of nickel and carbon structure for pristine and lixiviated Alyssum murale in biochars produced at different temperatures (200 to 800 °C) by slow (10 °C/min) and fast pyrolysis (~1° C/min) in tubular furnace is investigated by various analytical methods (Elemental analysis, X-ray Fluorescence, X-ray diffraction, X-ray photoelectron spectroscopy, Transmission electron microscopy, BET surface area N_2 and CO_2, H_2 chemisorption, 1H NMR ultra-fast MAS 100kHz, Calorimetry). At the temperature of 800 °C, carbon and nickel contents are measured about 72%wt and 2.75%wt (dry basis), respectively, while Ni° particles (~15 nm) and NiOx are detected. BET surface is measured at 301 m²/g by CO_2 adsorption at 273 K and 34 m²/g by N_2 adsorption at 77 K. The lixiviation of biomass leads to some significant modifications of the textural properties of the biochar produced at 800 °C (78%wt C and 1.25%wt Ni, BET surface is measured at 301 m²/g by CO_2 adsorption at 273 K and 68 m²/g by N_2 adsorption). The catalytic activity of nickel-enriched biochar is estimated on methane reforming reaction in a fixed bed reactor at 800 °C showing 10%mol CH_4 conversion for the experimental parameters used. Biochar structure is also investigated after catalytic treatment showing formation of graphene coke surrounding Ni° particles (Figure 1). Nickel-enriched biochar steam reforming will be also performed to identify the best conditions of this material valorisation as catalyst for H2 production.

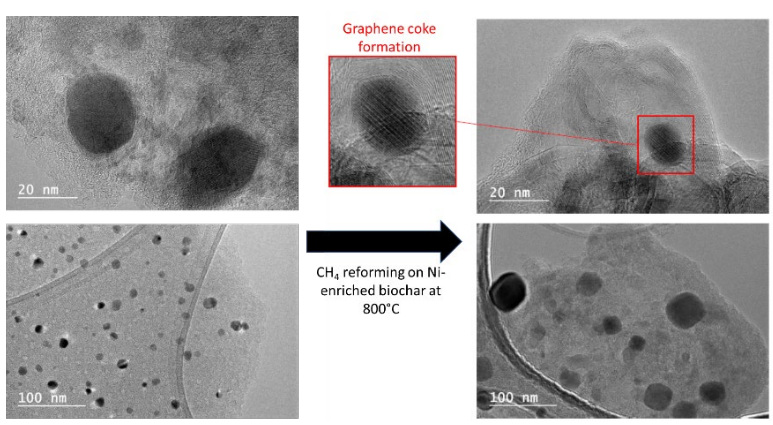

Figure 1: TEM analysis of Ni° particles in Nickel-enriched biochar produced at 800°C (a) and Ni° particles after catalytic CH_4 reforming (800 °C, 300 min)