

CHANGES IN CARBON STRUCTURE DISTRIBUTION AND NANOSTRUCTURE OF FUNCTIONALIZED BIOCHARS

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Key Words: biochar, carbon nanostructure, functionalization, catalyst.

Energetic vectors produced from the thermochemical conversion of biomass and waste is considered as environmental-friendly energy. The syngas composed of CO and H₂ at convenient ratio, could be used for various subsequent uses. However the industrial development is hold back by the production of unwanted by-products: tars and biochar/ash (aromatic hydrocarbons and solid residues respectively) which decrease the global efficiency yield and require very costly treatments. Some recent studies investigated potential applications to use these biochars for catalytic or sorbent applications, such as catalytic tar cracking or pollutants removal [1]. Biochars are cheap candidates and their functionalization is an opportunity for further development as an inexpensive catalyst from renewable resources. The functionalization may impact the carbonaceous matrix structure, the content of O-groups as well as the increase in mineral content [2, 3]. This study aims at understanding the structural changes occurring in the carbonaceous matrix of wood-based chars during their functionalization (oxygenation and mineral impregnation) for catalytic applications. This enabled to evaluate the best post-treatment conditions that would enhance the catalytic properties of these functional bio-sourced materials. The biochars produced using poplar wood were oxygenated in a O₂ / N₂ stream at different temperatures and duration times. The mineral impregnation was carried out on wood before pyrogasification or using a biomass enriched with minerals. Comparative studies regarding tar cracking have been performed and discussed in agreement with the mineral content and the modifications in carbon structures.

Distribution of carbon structures in biochar is more or less impacted by functionalization. On the one hand, the oxygenation at moderate temperature (280°C) does not highlight drastic change regarding the distribution of carbon structures between graphene-like sheets, defects in graphene-like sheets and small aromatic systems. This was the same general observation regarding wood pieces in biochar enriched with minerals. However some onion-like structures and interconnected cavities ~25 nm long were observed in biochars treated for a longer period due to a local reorganization of the graphene-sheets network. On the other hand, at the highest processing temperature, the amount of defects in graphene-like sheets and graphitic nanocrystallites were increased resulting in a higher amount of active sites. In addition, the matrix of this biochar was composed of homogeneous spherical cavities of 15-25 nm which were expected to enhance the reactivity toward hydrocarbon cracking. Biochars enriched with minerals showed also local defects in graphene sheets when mineral particles are embedded in the matrix. Therefore, this biochar is a promising catalyst for hydrocarbon cracking thanks to its strong activity given by the high mineral content and carbonaceous structure.

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