CHARACTERIZATION OF THE CARBON PRODUCED BY METHANE CRACKING IN A MOLTEN TIN REACTOR

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Abstract
Experimental tests of non-catalytic thermal methane cracking have been conducted at a fixed temperature (1070 °C) in a cylindric quartz reactor (i.d.= 1,5 cm, L= 20 cm) with capillary injection (d_{cap}= 0,25 mm) in homogenously gas phase and in the presence of molten tin (bubble column system). The use of molten tin can be an effective solution for methane cracking feasibility due to its high thermal conductivity which makes the gas heating faster and to its high density which can considerably simplify the carbon recovery operations. The effect of the presence of molten metals in the carbon formation and morphology has not been deeply investigated yet. Carbon morphology is a key parameter for the determination of its value. Aim of this study is to compare properties and morphology of carbon produced in homogeneous and molten tin methane cracking. Carbon samples were produced in different conditions: in the empty reactor and in the presence of molten bed for different tin heights (7 – 20 cm). Carbons were characterized by RAMAN spectroscopy, SEM and surface area measurements. The Raman spectra were acquired paying attention to the D, G, and 2D vibration bands pointing out that the amorphous structure was predominant carbon produced in homogeneous gas phase, while an increase in the crystallinity of the graphitic domains was obtained increasing the tin height. SEM images were obtained by a high-resolution AURIGA Zeiss scanning electron microscope equipped with an energy dispersive X-ray analyzer. As a result, the micro-structure of the carbon collected from the reactor in the absence of molten media was characterized by spherical stacked carbon particles (∼200–500 nm). In contrast, sheet-like structures with tin traces were observed in all the carbon samples produced in the molten media. According to the literature, this morphology seemed to be related to the bubbling configuration, since carbon particles were formed in the bubbles preferably at the liquid-gas interface. Methane decomposition likely took place at the gas-tin surface contact, which likely led to the formation of spherical sheets of carbon so that, once the bubbles broke up on the top surface of the tin bath, flat sheets overlaid.