

Physico-chemical nanomaterials science

Structural features of carbons produced using glucose, lactose, and saccharose

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Thermolysis of glucose, lactose, and saccharose in the inert atmosphere results in the mass loss up to 88 % (saccharose), 84.3 % (glucose), and 82.9 % (lactose) during heating to 1000°C. Chars prepared at 400°C contain different O- and H-containing functionalities, whose amounts decrease during oxidizing activation at 800°C and 1000°C. According to the IR spectra, certain amounts of these functionalities remain even after heating at 1000°C in the inert atmosphere. During heating of the chars in vacuum in the temperature-programmed desorption with mass-spectroscopic control experiments, desorption of O- and H-containing fragments is maximal at ~300°C.

Oxidizing activation of the chars with controlled amounts of oxygen penetrating into the closed vessels through nano-sized pores results in an increase in the porosity and specific surface area of carbons depending on the type of the used precursors. The maximum enhanced porosity is observed for lactose-based carbon activated at 1000°C. For saccharose-based carbon, the difference in the porosity of samples activated at 800°C and 1000°C is relatively small. For glucose-based carbon, a very strong decrease in the porosity is observed for carbon activated at 1000°C.

All carbons have nanopores and narrow mesopores, broad mesopores and macropores are practically absent. The hysteresis loops of the nitrogen adsorption-desorption isotherms are open for all chars and carbons with one exception of lactose-based carbon L1000 activated at 1000°C and possessing the maximal values of pore volume (V_p) and BET specific surface area (S_{BET}). These results can be explained by burn-off mainly of the outer layers of carbon particles and a small degree of burn-off in pores. The second process is maximal for L1000 as the most porous sample studied. An increase in the activation temperature leads to an increase in the conductivity of carbons that is maximal for L1000. This can be explained by deeper activation of this carbon and more effective removal of the O- and H-containing functionalities.