Nanocomposites and nanomaterials

Activated carbon fiber with functionalized surface

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Activated carbon fiber (ACF) is known as one of the best absorbents having considerable advantages over other commercial storage materials. The structure of ACF is characterized as a disordered three-dimensional network. There exists nanosized interstitial space called “nanopore” between nanographite domains. Most valuable features are due to such features of the material structure.

Chemical modification of surface layer substantially affects ACF properties. The work is focused on grafting functional groups to carbon surface with the aim to improve or extend the practical applications of ACFs.

The initial material was ACF (S_{BET}=900 m^2/g, V_S= 0.19 cm^3/g) produced by carbonization and steam activation of polyacrylonitrile in fibrous shape. ACF samples were treated with liquid bromine or bromine vapor in low-temperature gas discharge. The substitution of the grafted bromine for S-containing functional groups was performed using concentrated aqueous solution of sodium mercaptoacetate. Then ACF samples were boiled with HCl and treated with H_2O_2 to hydrolyze surface S-containing groups and oxidize them to SO_3H-ones. ACFs with surface strong acid groups seem to be active catalysts of some catalytic processes.

The amount of bromine was determined by the Volhard's method. The Boehm titration was used for determining the main types of oxygen-containing groups. The study of the surface functionalities was carried out by analyzing the data obtained by thermogravimetry (TG) together with thermoprogrammed desorption with mass-spectrometry detection of desorption products (TPD-MS). The SO_3H-containing carbon fibers were tested in model catalytic reaction of propan-2-ol dehydration.

Chemical analysis, TG and TPD-MS data confirm obtaining samples with needed functional groups. Total amount of fixed Br depends on the method of treatment and it is time-depended for samples obtained in low-temperature gas discharge. Bromination in liquid phase is accompanied by oxidation. All SO_3H-containing samples are active in propan-2-ol dehydration. Pre-bromination provides a higher concentration of SO_3H-groups and pre-brominated ACF samples are more active in the studied reaction. Obtained catalysts are characterized by high thermal stability.