Chemical Characterization of Activated Carbon Fibers and Activated Carbons

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The objective of this laboratory is the chemical characterization of carbon materials using several methods to obtain information without using expensive instruments. During this lab the students determine the potential of zero charge (pzc) by mass titrations and quantify the acidic and basic sites by acid–base titrations. This lab is useful in two aspects:

- In specific disciplines about carbon materials, the methods proposed in this article are important for the chemical characterization of the materials. For instance, the data are crucial to explain the results in studies of liquid-phase adsorption, such as those previously published in this *Journal (1–3)* or to analyze samples produced by chemical modification methods such as oxidation in the liquid phase with nitric acid *(4)*, sulfuric acid *(5)*, hydrogen peroxide *(5)*, or by thermal treatments under controlled atmosphere *(6, 7)*.
- In general chemistry disciplines, the lab can interest students in the basic acid–base concepts and titrations as they are applied to materials that have a great importance for environmental protection and a significant number of daily life applications.

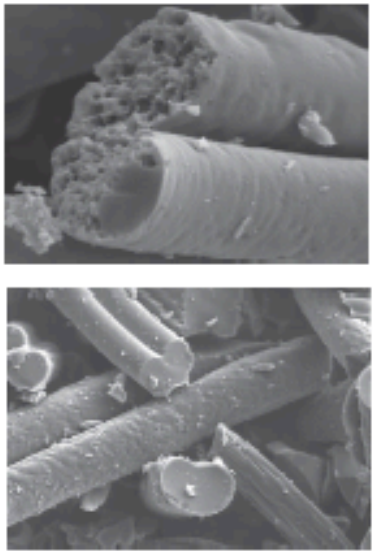

Figure 1. Activated carbon fiber from commercial textile acrylic fibers (8).

Activated carbons (AC) and activated carbon fibers (ACF) are examined. Both activated products have well developed porosity and surface chemistry but also have some interesting differences. A scanning electron micrograph clearly shows that the ACF is in the form of filaments (Figure 1). In this material the porosity is predominantly microporosity (pore width, d_p, < 2 nm) and opens directly to the exterior. In AC, the microstructure is normally spherical and the porosity decreases from macro (d_p > 50 nm) to meso (2 nm < d_p < 50 nm) to microporosity from the external surface towards the interior of the material (Figure 2).

These materials have a tremendous number of applications, which include antibacterial wound dressings, disposable gas masks, methane storage, polarizable electrodes, catalysis applications, SO_x and NO_x removal, gas separation, cigarette filters, skin substitutes, and adsorption of pollutants such as volatile organic compounds, hydrocarbons, nickel, copper, lead, and mercury. The applications in the gas phase are mainly due to the porous structure whereas the applications in the liquid phase are mainly dependent on the chemical structure of the materials. In this sense, the complete characterization of the materials, including the chemical characterization, is of great importance.

Experimental Procedure

Materials

This lab has been applied to a variety of different carbon materials, which include commercial activated carbons from Norit N.V. (Norit S51) and Merck (p.a., ref* 2186) and activated carbon fibers from Nipon Kynol Inc. (ACF-1603-15) and samples produced in our laboratory from acrylic textile fibers.

Acid–Base Titrations

The carbon material, 300 mg, was equilibrated with 60.0 mL of 0.01 mol L^{-1} NaOH for 48 h with stirring at 25.0 °C.

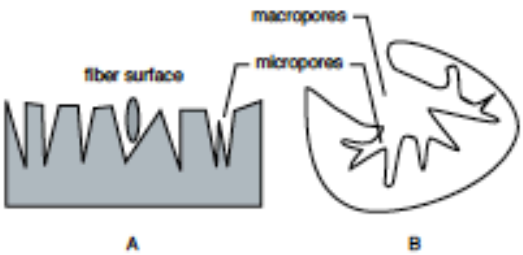

Figure 2. Representation of the porous structure of activated carbon fibers (A) and activated carbons (B).