ADSORPTION AND SURFACE PROPERTIES OF METAL ION TREATED ACTIVATED CARBON FIBER

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Introduction

Extensive use of activated carbon and fiber for air pollution and waste water has been known for last decades. Recently, activated carbon fibers(ACFs) are highly microporous carbons with large surface area and pore volume giving rise to good and rapid adsorption and desorption properties for gases and metals. The adsorption-desorption of metallic ions on ACFs is an important process in the preparation of metal supported catalysts and adsorbents with increasing usage and applications. It has been proved that ACFs have outstanding reaction property for some metals[1]. The chemical and physical properties and antibacterial effects of metal treated porous carbon have been studied as a function of chemical reaction like ionc exchange in a solution of $AgNO_3$[2]. In this study, We were obtained physicochemical properties and the antibacterial effects of the metal ion treated ACF. And also, we will discuss of reaction mechanism between metal ion and carbon functional groups.

Experimental

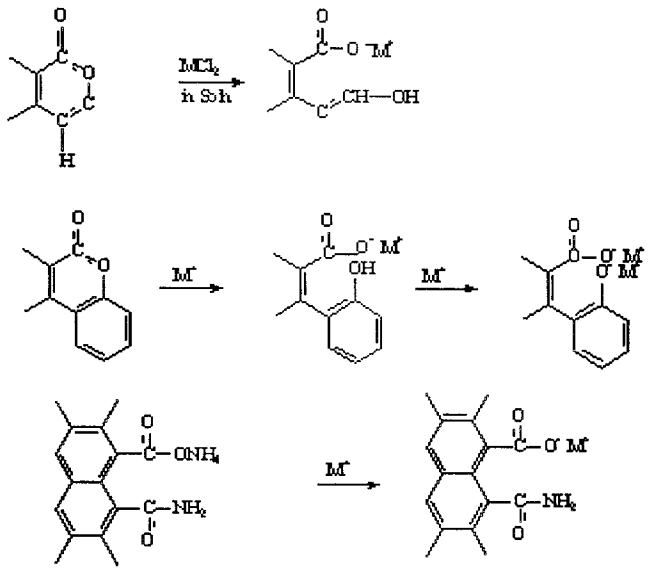
As a raw material, we employed commercial grade ACF. We noticed its low sulfur contents and high surface area. $CuCl_2$(Aldrich, 99+ %, ACS reagent) was used as a cupper source for Cu treatment. $CuCl_2$ were dissolved in doubly distilled water to prepare a series of solutions. Employing Sibata P-850 adsorption apparatus and liquid nitrogen method, we obtained adsorption isotherms. The sample was outgassed for several hours at 200℃ and nominal system vacuum of about 10^{-5} torr for removal of any physically adsorbed materials from the micropores. Scanning electron microscopy(SEM, Topcon sm-300, Japan) was used to observe the surface state and structure of Cu treated ACF and the physical state of the cupper. Antibacterial activity against *E. coli* was tested in cultivated culture medium.

Results and discussion

The studies on the adsorption properties and the antibacterial effects of Cu treated ACF were carried out. In Fig. 1, the adsorption isotherms for the series of metal-impregnated ACF are shown as a function of relative pressure. According to BET classification[3], these isotherms can be assigned to typical Type-I. From the isotherms, we noticed that the amount of adsorbed N_2 is abruptly increased in the region where the relative pressure is lower than 0.2, but the volume is nearly constant once the pressure becomes higher than 0.2. This phenomenon is known as typical characteristics for microporous carbons. In these isotherms, the cross point between sharp knee band and plateau region could be the point where the micropore filling is completed. For the adsorbents consisted only with very fine micropore, the mechanism of adsorption can be explained by pore filling rather than surface coverage. The specific surface areas(S_{BET}) of ACF can be determined from N_2 gas adsorption measurements. In our study, the areas of Cu treated ACF are distributed to 688.20~887.75 m^2/g range.

To investigate surface state of the ACF prior to and after the metel treatment, we obtained scanning electron microscopy(SEM). In Fig. 2, although it was not possible to observe micropores on the surface, it was possible to find metals.

In order to antibacterial activity effects of Cu treated ACF, we employed *E. coli* known as a kind of colon bacillus. Antibacterial activity against *E. coli* was examined in cultivated culture medium for 24 hour. From these results, we also observe that the areas of antibacterial activity become larger with the increase of the amount of Cu treated. The manner of spatial distribution of acidic functional groups of carbon affects its chemical properties, and antibacterial effects. And the chemical properties of the carbon surface are modified



by ion exchange between functional group on the carbon surface and metal ions a solution. Metal ions in solution react chemically with functional groups such a neighbering carboxylic and hydroxyl groups, ammonium salts[4]. In the relation between cells and metals on the carbon, we suggested that metal chemically reacted protein or any special enzyme have activity of antibacterial effect. Especially mercury(Hg), silver(Ag), cupper(Cu) can be observed characteristic phenomenon so called "oligodynamic action" in low concentration.[5]

Conclusion

We studied adsorption isotherm, surface properties and antibacterial activity of Cu treated ACF. The BET surface area of Cu treated ACF are distributed to 688.20~887.75 m^2/g. The adsorption results show that BET surface areas move gradually to lower value with increasing treated Cu mole concentration. And we also observed that the activity of *E. coli* in kind of colon bacillus increases gradually to larger range with increasing Cu mole ratio. From these results, we suggest the antibacterial mechanism for metal treated ACF.

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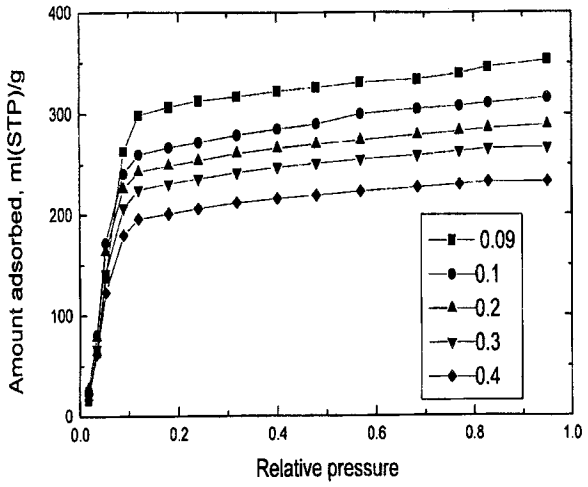

Fig. 1. Adsorption isotherm of nitrogen on the Cu treated ACF.

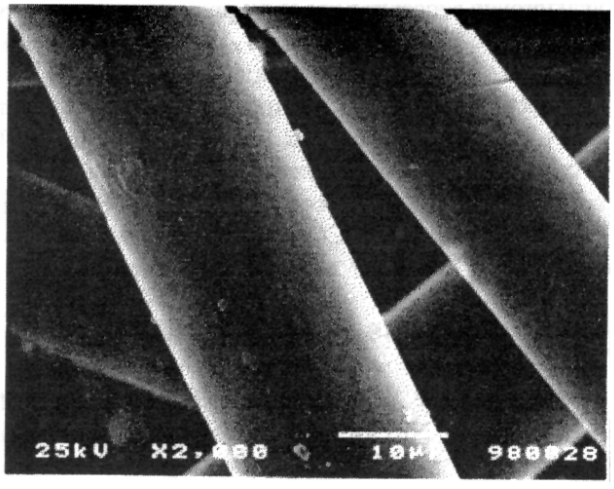

Fig. 2. SEM micrograph of Cu treated ACF.