POSTER

SURFACE AND ADSORPTION CHARACTERISTICS OF ACTIVATED CARBON FIBERS TREATED WITH OZONE IN AQUEOUS SOLUTIONS

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INTRODUCTION

Until now, treatment with ozone on carbon fiber has been used in gas-phase oxidative treatments for surface modification. The gaseous treatment is, however, generally very drastic and causes severe degradation and excessive pitting of the carbon fiber surface. Most liquid-phase oxidative treatments are milder and generally do not cause excessive pitting and degradation of the carbon fiber, but less effective compared with the gaseous methods[1].

The present work is concerned with surface treatment on activated carbon fibers with ozone in aqueous solutions to demonstrate the new method, which is milder and more efficient for the developing of their porous structure and surface properties.

EXPERIMENTS

The pitch-based ACF(A-7, AD'ALL Co. Japan) is used as a base material. The ACFs are subjected to treatment with ozone in different conditions. N_2 adsorption isotherms were measured at 77K by volumetric method (Autosorb-1, Quantachrome). Surface acidities are determined by Boehm's method (Metrohm titroprocesser Model 602)[2]. Qualitative analysis of surface functional groups is made by the FT-IR spectrophotometer (Model IFS88, Burker). TGA/DSC and SEM analyses are also measured. Decolorizations of methylene blue are conducted at 30℃, and analyzed by UV-Vis spectrophotometer (Perkin Elmer Model 1100B) at 665nm.

RESULTS AND DISCUSSION

Nitrogen adsorption isotherms are used to determine specific surface area, and pore structure of activated carbon fibers treated with ozone in different solutions.

Specific surface area and total pore volume of ACFs are apparently increased without considerable weight loss with increasing treatment time and concentration. This result is in contrast with results of common liquid-phase treatment, which could be explained by blocking of the narrow pores by surface complexes introduced.

In the pore size distributions, the micropore % of the total pore volume is slightly decreased with increasing treatment time and concentration. On the other hand, macropore volume is increased by about 7 percent. Average pore radius is also increased slightly. This means that mild reaction of hydroxyl radicals with the surface is taking place homogeneously on carbon fibers. This could be explained by indirect reaction of ozone on the surface[3]. The reaction of molecular ozone (standard oxidation-reduction potential, E° : + 2.07V), which is one of powerful oxidizing agents, is particularly selective to unsaturated bonds and somewhat slower. Whereas, in alkaline solutions, the ozone decomposes to form hydroxyl radical, •OH (E° : + 3.06V), which then reacts more rapidly and much less selectively. The comparison of SEM photographs with directly treated surface and indirectly treated surface with ozone in aqueous media could support this explanation.

Surface acidity of ACFs is also dramatically increased with increasing treatment time and concentration. Methylene blue as cationic organics is preferentially adsorbed on negatively charged acidic surfaces[4].

From the analyse of FT-IR spectra, predominant surface functional groups on ACFs treated with ozone in alkali solutions, however, are different from non- treated ACF. It seem that most carboxylic groups are transformed to $-O^-$ and CO_2 by the reaction of $-COO^-$ with hydroxyl radicals. The results from TGA/DSC analyses of treated and non-treated ACFs after drying at 150℃ for 24hr show weight-loss of adsorbed H_2O of 1.58% and 5.16%, and desorption temperature of 36.05℃ and 64.4℃, respectively. This is in good agreement with surface acidity results.

CONCLUSION

New oxidative surface treatment method of carbon fibers has been developed by reaction of ozone in different alkali solutions. This method is milder and more effective for the development of texture and surface properties than currently used methods.

REFERENCES

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2. H.P. Boehm, Adv. in Catalysis, 16, 198 (1966)
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4. S.S. Barton, Carbon, 25, 3, 343 (1987)

Table 1. Textural and Chemical Characteristics of ACFs treated with ozone and AC

Item \ Treated Time (min)		0	10	30	50	80	AC
Textural properties	$S_{BET}(m^2/g)$	697	1337	2654	2641	2660	750
	total pore volume (cc/g)	0.278	0.567	1.772	1.146	1.705	0.41
	macropore volume (cc/g)	0.019 (6.95%)	0.059 (10.34%)	0.231 (13.04%)	0.159 (13.86%)	0.200 (11.73%)	0.04 (9.76%)
	micropore volume (cc/g)	0.258 (93.05%)	0.508 (89.66%)	1.541 (86.96%)	0.587 (86.14%)	1.505 (88.27%)	0.37 (90.24%)
	Ave. pore radius (Å)	7.97	8.474	8.599	8.674	8.544	11.1
Chemical property	surface acidity (meq./g)	0.31	0.379	0.625	0.656	0.576	-

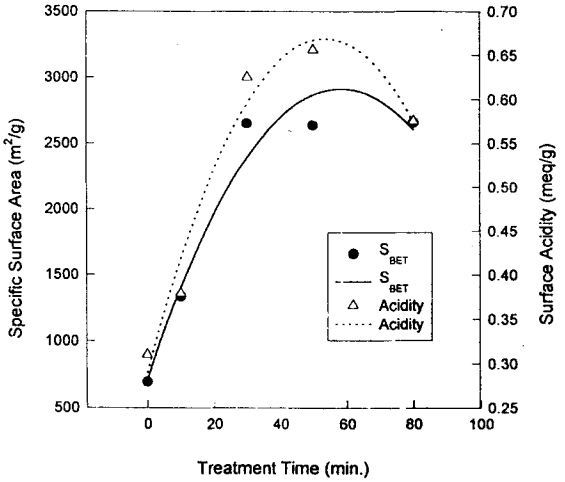

Fig.1 Development of specific surface area (S_{BET}) and surface acidity on treatment of activated carbon fiber with ozone in 1M NaOH solution at 20 °C

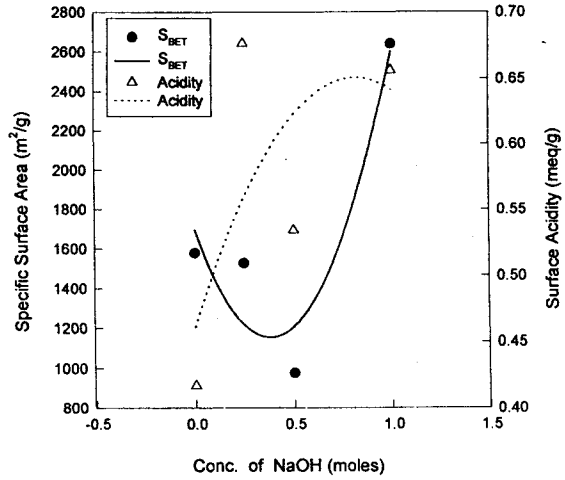

Fig. 2 Development of specific surface area (S_{BET}) and surface acidity on treatment of activated carbon fiber with ozone in different concentration of NaOH solution

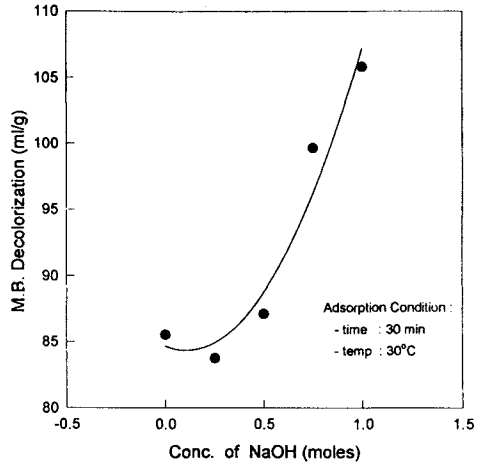

Fig. 3 Decolorization of methylene blue v.s. concentration of NaOH treated on activated carbon fiber.