

PREPARATION AND CHARACTERIZATION OF PITCH-BASED ACTIVATED CARBON FIBER SUPPORTING SILVER

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Introduction

In recent years, it has been found that loading with metal compound onto surface ACF is an effective way to improve the properties of ACF and add special functions to ACF. ACF supported with different metals show different special properties[1-4]: ACF(Ag) have good antibacterial property; ACF(Mn or Fe or Cu,) is good at adsorption to odor vapor. There are many ways to load metal particles on to the ACF, such as immersion, blending, electrical and deposition, among which immersion and blending are commonly used. Blending method increase the difficulty of fiber spinning, and some metal imbedded in the fiber interior structure, as “dead part”, can not play their roles. Therefore, immersion method is used because it is simple and easy to control. Due to the decrease of the SSA of ACF after loaded with metal, CF are immersed with cobalt salt solution before activation to get ACF with larger SSA. In this paper, ACFs supported silver, ACF(Ag), were prepared, and the effects of immersion on the pore structure and surface of the resultant ACF were also studied.

Experimental

2.1 Preparation of ACF supporting metal

Pitch-based CF were activated with steam at 1173K for 60 min and the resultant activated carbon fibers (ACF) were immersed in silver nitrate aqueous solution with different concentration, soak time to load silver onto the fiber. Finally, the fibers were heated to certain temperatures for decomposition.

2.2 Measurement and characterization

The specific surface areas of the resultant ACF were determined by N₂ adsorption isotherm at 77K. The total SSA (S) was calculated by BET method, and the SSA and volume of micropores (S_i and V_i) were calculated by t method. The external surface area, S_e, was the difference S and S_i. Additional information about pore size distribution was obtained using H-K method. The silver on the surface of the ACF was observed by SEM, and its content was determined by atomic absorption spectrophotometry.

Results and discussion

3.1 Relationship between silver amount and immersion parameters

The silver amount onto ACFs was influenced by the concentration of AgNO_3 solution and immersion time, just as shown in Table 3.3.

Table 3.1 Effects of immersion parameters on the silver amount

sample	Concentration(mol/L)	Soak time(hrs)	silver amount(wt%)
1	0.01	15	2.3
2	0.02	17	9.3
3	0.05	8	14.3
4	0.05	26	17.5
5	0.10	19	21.9
6	0.10	24	27.6

As indicated in Table 3.1, the silver amount onto ACFs depended on both concentrations of the solution and the soak time. With the concentration of the solution increased and the immersion time prolonged, the silver amount onto the ACF became larger. Therefore, the concentration and immersion time is crucial to control the silver amount.

3.2 Effect of silver loading on the pore structure of ACFs

It is obviously that silver loaded on the surface of ACF blocked some pores and led SSA of ACFs decreased, and the temperature of decomposition also changed the pore structures. The SSA and pore structures of the ACF before (ACF1 and ACF2) and after silver-loading (ACF1(Ag) and ACF2(Ag))were shown in Table 3.4.

Table 3.2 The SSA and pore structure of ACF before and after silver loading (silver immersion: 0.1mol/L, 24 hours; decomposition temperature: 673K)

	S (m^2/g)	Si (m^2/g)	Se (m^2/g)	Vi (cc/g)	Pore size (\AA)
ACF1	2764	2123	641	0.8725	5.6
ACF1(Ag)	1332	934	398	0.3781	5.5
ACF2	3269	2670	599	1.0701	5.3
ACF2(Ag)	819	714	105	0.2854	5.2

From Table 3.2, we can see that SSA decreased greatly, and the pore size also became smaller after decomposition. Many micropores disappeared and non-micropore became narrow. For ACF2, although the initial SSA is higher, the SSA after silver loading became smaller than that of ACF1. The reason may be related to the cobalt left in the fiber and still need to study in detail.

3.3 Morphologies of the ACF supporting silver

After immersed in the silver nitrate solution for a given time, the silver was supported on the ACFs, as shown in Figure 3.1.

Figure 3.1 show that after silver immersion, there are lots of silver particle on the surface of ACFs. Their shapes varied with the immersion concentration and time. After heat-treatment, less large silver particles were observed on the surface of the

ACF, which were shown in Figure 3.2. That means that silver was rearranged during the decomposition stage and became smaller, so the size of silver particles was related to the decomposition temperature.

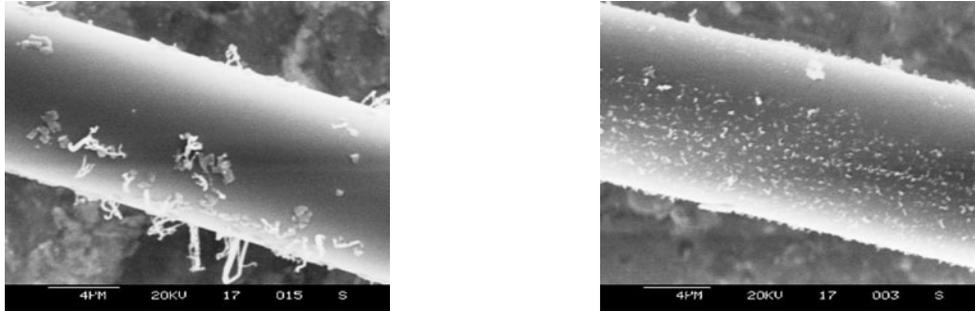


Figure 3.1 SEM photographs of the ACFs supported silver (Concentration: 0.10mol/L; soak time: 24hrs)

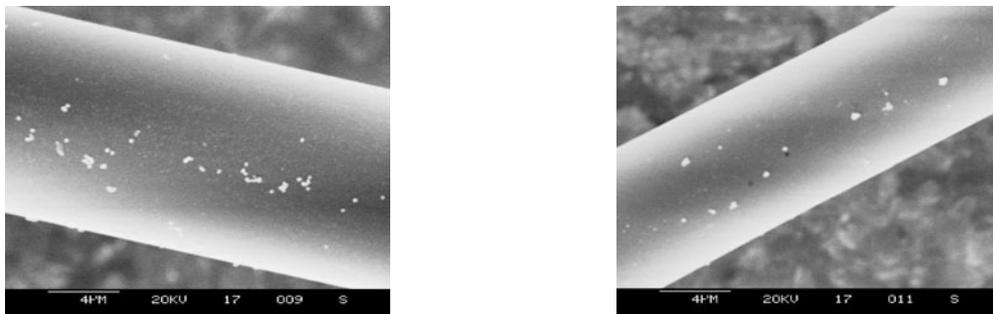


Figure 3.2 SEM photographs of the ACFs supported silver after heat-treatment

Conclusions

Silver immersion causes SSA of ACF decrease, and heat-treatment causes pore diameter of ACF(Ag) decrease. The SSA of ACF(Ag) is related to many factors.

References

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