Preparation of Activated Carbon Fiber for Electrodes of Electric Double-Layer Capacitor from Heavy Oil

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Introduction

Recently, many concerns focus on electrodes of EDLC. EDLC has high power density, reversible kinetic mechanism, high charge-discharge efficiency (90-96%), semi-permanent life time and wide temperature. Capacitance of EDLC, with ACF electrodes, is influenced by pore size, structure, functional group and conductivity[1].

In this work, pitch precursor with appropriate softening point was prepared from pyrolysis fuel oil(PFO, heavy oil) by chemical reaction. The precursor was spun, stabilized, densified, carbonized and finally activated to be activated carbon fiber. The pore size distribution and absorption properties of densified ACFs were examined under activation conditions and then prepared to be a electrode for EDLC. Charge-discharge behaviors of the electrodes were examined on the basis of the activation conditions.

Experimental

Pitch fiber was obtained by melt spinner(Fig. 1), and then stabilized to prevent melting during further process at high temperatures. Stabilized fiber was densified by hot presser and carbonized at 1,000 ℃ for 1hr. The densified ACF was obtained from CF through steam activation at 800～1000℃. The overall program of experiment is in Figure 2. Each product obtained were analyzed by various apparatus such as NMR, FT-IR, XRD and SEM.

Results and Discussion

Table 1 shows the characteristics of source PFO and precursor. Precursor has the higher aromaticity and softening point rises to 265℃ from 40℃, indicating that molecular weight was raised by chemical reaction.

Figure 3 shows the polarized light microphotographs of stabilized and carbonized fibers. All fibers were isotropic, indicating that suitable to preparation of ACF.

SEM microphotographs of densified stabilized fiber disk were in Figure 4. All fibers were high-densified effectively without melting, with density of 1.1g/cc. This method compensates the limits of ACF fabric which has low specific density in application of EDLC electrode.

ACF was prepared by steam activation at 900℃, H_2O/N_2=0.4, for 30min with 41% burn-off. This ACF has the specific surface area of 1,541m^2/g.

Conclusions

Precursor with good spinnability was obtained from PFO by chemical reaction. This precursor has the higher aromaticity and softening point than those of PFO. Densified Carbon fiber was prepared by oxidative stabilization, densification and carbonization. The ACF formed from steam activation exhibits a surface area of 1,541m^2/g.

Further study will be performed on steam activation, absorption of ACFs and charge-discharge properties

Acknowledgements

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Reference

1. Kinoshita K, Chu X, The Electrochemical Society Proceedings, 1995;29:171-181.

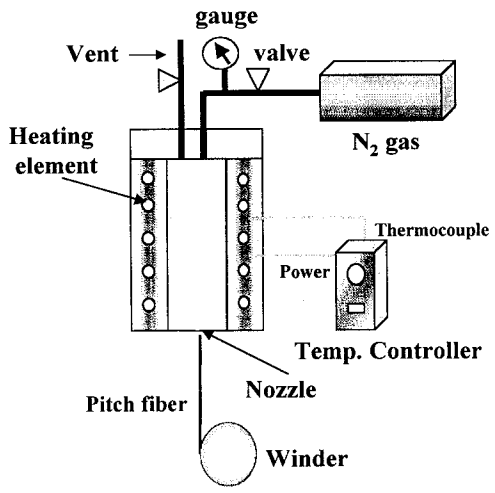

Fig. 1. Schematic diagram of melt spinner.

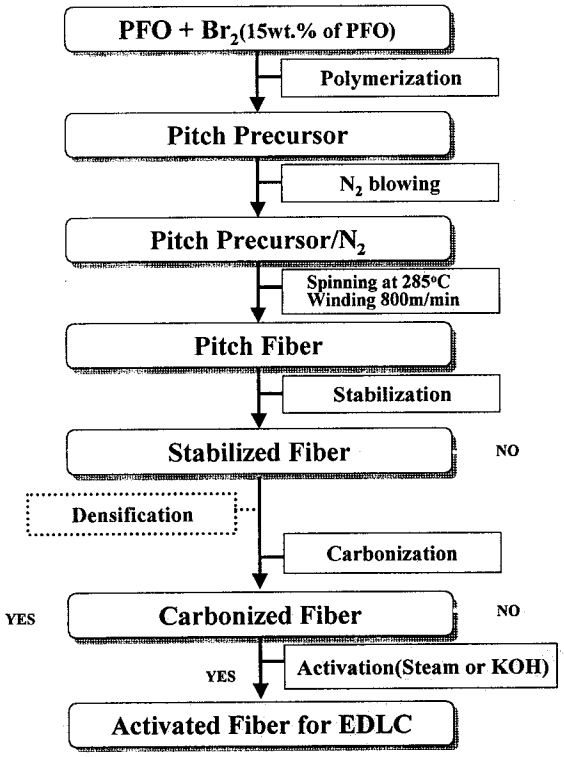

Fig. 2. The overall program of experiment.

Table 1. Some characteristics of PFO and precursor

Prop. / Sample	Yield (%)	Softening Point (℃)	C_{ar}/C_{al}*	H_{ar}/H_{al}*
PFO	-	40	1.268	1.499
Precursor	42.1	264	1.492	1.654

* Determined by ^{13}C NMR and ^{1}H NMR

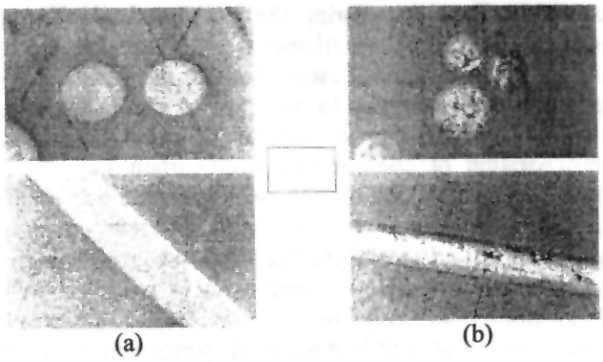

Fig. 3. Polarized light microphotographs of cross and longitudinal direction of fibers.
(a) Stabilized fiber (b) Carbonized fiber

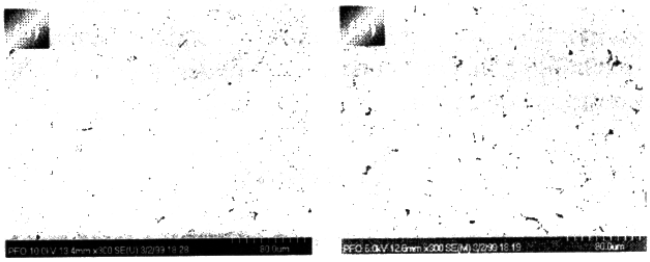

Fig. 4. SEM microphotographs of high-density stabilized fiber pressed at 20Mpa, 400℃/10min.
(a) longitudinal (b) cross section