

Activated Carbon with High Capacitance for Electrical Double Layer Capacitor (EDLC)

1. Introduction

The electrical double layer capacitor (EDLC) is an energy-storage device utilizing an electrical double layer formed by an electrode containing activated carbon and an electrolyte. The mechanism of charge and discharge is based on a simple adsorption and desorption action. Accordingly, compared with rechargeable batteries such as nickel metal hydride batteries and lithium-ion batteries, in which the mechanism of charge and discharge are based on electrochemical reactions, EDLC has advantageous characteristics of (1) being able to be electrically charged and discharged rapidly, (2) applicability in a wide temperature range, and (3) having a long cycle life. Conventional EDLCs, however, have a drawback of low energy density so their main use is limited to small-scale memory backup power supplies for cellular phones, personal computers, etc.

Recently, however, activated carbon for EDLC has been improved, increasing the energy density of EDLC. As a result, EDLCs are now used in larger applications such as backup power supplies for electrically controlled equipment in automobiles. Furthermore, large-scale EDLCs are now being developed as a supporting power supply for hybrid cars and fuel cell cars, and so the market for EDLC is expected to be larger.

The characteristics of EDLC largely depend on the activated carbon used in the electrode. JFE Steel and JFE Chemical have developed an activated carbon having high electrostatic capacitance using an exclusive carbon material as the raw material, which was developed by the coal-tar pitch treatment technology which has a long track record as a core technology, and by combining a special activation technology. This report describes the developed activated carbon.

2. Characteristics

By using an exclusive carbon material as the raw material, which was developed by the coal-tar pitch treatment technology in which JFE Steel and JFE Chemical have much experience, and by combining a special

activation technology, the properties of the powder can be controlled as follows:

- (1) Control of specific surface area and average pore diameter
- (2) Control of average particle size to a range of 2 to 30 μm
- (3) Minimization of impurities

As a result, the activated carbon gives excellent EDLC characteristics:

- (1) Large capacitance: high density leads to high volumetric capacitance
- (2) Excellent rate characteristics: control of shape and particle size provides an electrode structure having low diffusion resistance of electrolyte ions
- (3) Low internal resistance: provides high conductivity
- (4) Excellent durability: deterioration of the electrolyte and other materials is prevented by reducing impurities

3. Product Line-up

Photo 1 shows SEM images of the activated carbon developed by JFE Steel and JFE Chemical. **Table 1** shows the characteristics of activated carbon and the performance of a capacitor using the activated carbon.

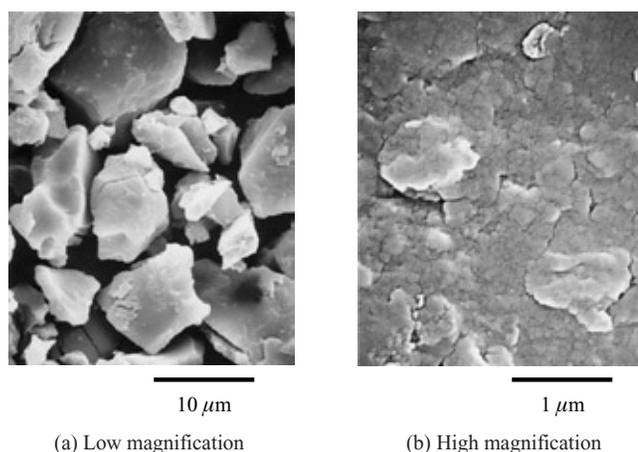


Photo 1 SEM observations of the activated carbon developed by JFE Steel

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Table 1 Specification of the activated carbon

Powder characterization		
Specific surface area	(m ² /g)	1 000–2 000
Average pore diameter	(nm)	1.85–2.10
Packed density	(g/cm ³)	0.55–0.90
Average particle size	(μm)	2–30
Impurities		
Potassium	(ppm)	100≧
Iron	(ppm)	100≧
Surface functional group	(mmol/g)	0.5≧
EDLC capacitance characterization		
Galvanometric capacitance	(F/g)	30–42
Volumetric capacitance	(F/cm ³)	23–30

JFE Chemical is attractive to customers for its high capacitance, low resistance, and high rate characteristics, owing to the exclusive carbon material as the raw material and to the combination of special activation technology.

JFE Steel and JFE Chemical are now conducting R&D to meet various consumer needs, including higher capacitance.

For Further Information, Please Contact to:

Chemical Res. Dept., Steel Res. Lab., JFE Steel
 Phone: (81) 43-262-4708
 Carbon Material Dept., JFE Chemical
 Phone: (81) 43-262-3717

4. Conclusion

The activated carbon developed by JFE Steel and