

Various electrode materials have been considered and tested. At the moment the most widespread active layer used in electrochemical capacitors is activated carbon. Metal oxides and conducting polymers are further alternatives. In our research group, interest is focussed on activated glassy carbon (GC) as electrode material [1]. The surface of the bulk glassy carbon is transformed by electrochemical or chemical activation, so that a high surface area active layer results. Either aqueous (H_2SO_4) or organic [$(\text{CH}_3\text{CH}_2)_4\text{-NBF}_4$ in acetonitrile] electrolyte can be used.

After the first promising results on a 20 cm² unit cell (2 F, 65 mohm at 1 kHz, 1 V dc bias) the next step was to build a GC capacitor stack with four electrodes (three unit cells). The GC electrodes were 1 mm thick and 20 cm² in area. A porous polypropylene film was used as separator which was wetted with 3 M sulfuric acid. At 3 V dc bias, a capacity of 0.3 F at 0.1 Hz was measured by ac impedance spectroscopy.

We present ac impedance data of a GC capacitor stack with up to seven unit cells with bipolar plates of 0.1 mm in thickness. The frequency dependence of the active layer capacitance will be shown. A capacity of about 1 F per unit cell is expected. In order to lower the internal resistance, much attention has been paid to the separator and the end-plate contacts.

Acknowledgement

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Reference

- [1] M.G. Sullivan, R. Kötz, O. Haas, in F.M. Delnick and M. Tomkiewicz (eds.), *Electrochemical Capacitors, Proc. Electrochem. Soc.*, 95–29, ECS Proceedings Series, Pennington, NJ (1996), p. 198.

P7

Improvements in lithium/CF_x cells

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The Li/CF_x primary cell is very attractive to many consumers because of its high specific energy, enhanced safety, and operating voltage (close to that of an Li/MnO₂ cell). Recently ECO has developed an improved cathode material for Li/CF_x primary cells. Based on preliminary investigations of different fluorocarbons with the same degree of fluorination, we have determined that electrochemical capacity and operating voltage of CF_x material does not depend on the physical properties of the precursor material at low operating current densities (less than 0.2 mA/cm⁻²). However, at

higher current densities, all electrochemical parameters of CF_x, including voltage delay, OCV operating voltage and electrochemical capacity increase with increased surface area of the cathode material precursor.

We have demonstrated the importance of precursor surface area in tests using ‘‘AA’’- and ‘‘D’’-size Li/CF_x cells with cathode material prepared from fluorinated carbonized fibres with high surface area. As part of this work we have also developed in-house technology for densification of the cathode material, ‘‘AA’’- size cells utilizing this cathode material provide discharge capacities up to 2.5 Ah and perform extremely well at low, moderate and high rates. Such improved performance combined with long shelf life, wide operating temperature range, high OCV, enhanced safety, and minimal voltage delay makes these new ECO Li/CF_x cells extremely attractive power sources.

In our poster, we present data on the performance of ‘‘AA’’- and ‘‘D’’-size cells made with this improved cathode material; performance as a function of rate (up to 350 mA for ‘‘AA’’- size), of electrolyte composition and of test temperature (from –5°C up to 160°C) will be described.

Observed cell performance exceeds that of Li/CF_x cells with the same internal volume manufactured by Panasonic by at least 50%.

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The stress-controlled transport of lithium through the graphite electrode under the co-existence of two staged-phases

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Lithium transport through the graphite electrode in the coexistence of two staged-phases has been investigated in 1 M LiAsF₆-EC(ethylene carbonate)/DEC(diethyl carbonate) nonaqueous solution by using a potentiostatic current transient technique supplemented by a lithium charging/discharging experiment and ac-impedance spectroscopy. An attractive interaction between the intercalated lithium ion and graphite lattice is indicated from the decreased diffusivity value with increasing lithium content in the lithiated graphite electrode in the presence of single staged-phase.

This attractive interaction gives rise to the stage transformation in the electrode, which can be accounted for by the potential plateaus in charge/discharge curves. From the results of the potentiostatic current transients, it is suggested that the stage transformation in lithiated graphite electrode is accompanied by the limited transport of lithium through the electrode for which the stress generated by staged-phase boundary is responsible. The stress-controlled transport of lithium through the graphite structure was substantiated by