BATTERY GRAPHITES MEETING THE REQUIREMENTS OF PC AND γ-BL ELECTROLYTES

W. Kohs[1], H. Schröttner[2], I. Barsukov[3], J. Doninger[3], F. Hofer[2], M. Winter[1] and J. O. Besenhard[1]

[1] Institute for Chemical Technology of Inorganic Materials, Graz University of Technology, Austria
[2] Research Institute for Electron Microscopy, Graz University of Technology, Austria
[3] Superior Graphite Co., Chicago, USA

Introduction

Propylene carbonate (PC) and γ-Butyrolactone (γ-BL) based electrolytes are known for their good low and high temperature behaviour. Unfortunately these electrolytes have only very limited abilities to form a protective solid electrolyte interphase (SEI) on the surface of graphite anodes. Beside approaching this problem with electrolyte additives there are also different battery graphites supporting the SEI formation and showing a good cycling stability.
Boron doped graphites, which have already been described as anode materials in lithium-ion cells [1, 2], and graphites especially prepared with high contents of rhombohedral phase [3, 4] afford the SEI formation even under bad conditions and show superior properties in these aggressive electrolytes.

Experimental

The battery graphites were manufactured by Superior Graphite Co.. Gas adsorption measurements were done using a Quantachrome Autosorb-1. A Bruker AXS D5005 θ/θ diffractometer was used for the X-ray diffraction measurements (XRD).

Electrochemical charge/discharge experiments were performed at 25°C using glass cells and a three-electrode setup with lithium as counter and reference electrode. The electrolytes were prepared from commercial battery grade solvents and conducting salts (Merck, Honeywell, Mitsubishi Chemical). Graphite electrodes of 0.9-1.2 mg effective mass and 4 % (wt.) Poly(vinylidene fluoride) were prepared using stainless steel grid as current collector, effective area 4 × 4 mm^2.

Results and Discussion

The results from the gas adsorption measurements and the XRD investigations are shown in Table 1. The boron content of the boron doped graphites is ~2.5 %.

Corresponding author: Wolfram Kohs
Phone Number: +43 (0) 316 873 8763, Fax Number: +43 (0) 316 873 8272
E-mail: kwolfi@sbox.tu-graz.ac.at

Table 1 *Specific surface area (BET, N_2) and content of rhombohedral phase of the investigated graphites*

Graphite	Specific surface ($m^2.g^{-1}$)	Rhombohedral phase (%)
SO-X	3.6	~ 0
SO-Y	5.3	~ 0
SO-23β	4.2	~ 23
SO-26β	4.6	~ 26

Using PC:γ-BL as electrolyte the SO-X started better than the SO-Y indicated by a much higher efficiency in the first cycle (Fig. 1.). However, after longer cycling the capacity of SO-Y remained more stable than that of SO-X.
Comparing the two rhombohedral graphites the SO-23β showed a better 1st cycle efficiency and a higher and much more stable discharge capacity (Fig. 2).

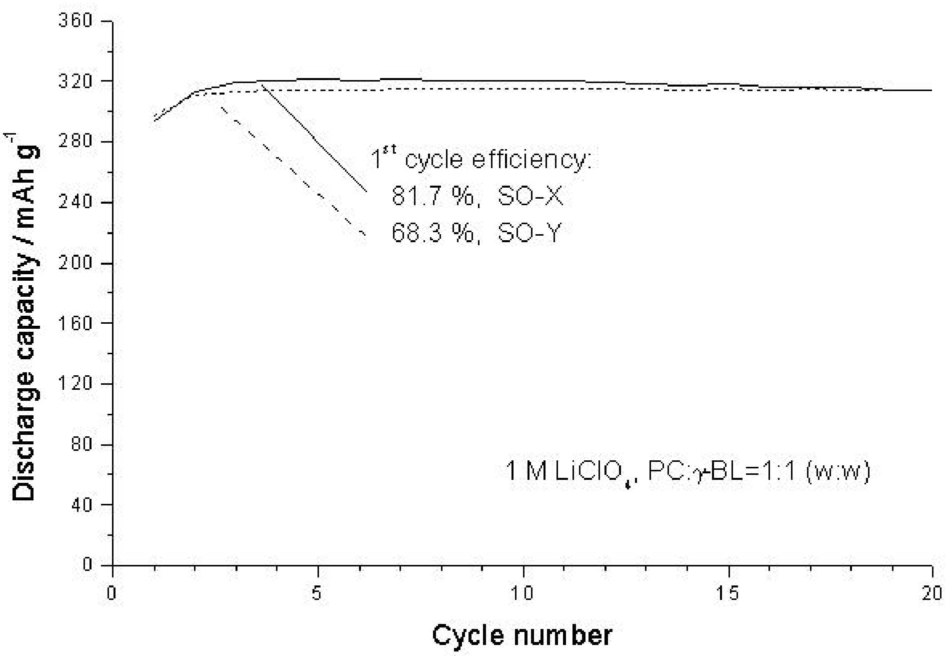

Fig. 1 *Progress of the discharge capacities of the boron doped graphites SO-X and SO-Y. I_{charge}= -100 mA/g - U=24 mV vs. Li/Li$^+$, U=24 mV (=const.) for t=1 h, $I_{discharge}$=100 mA/g - U=1500 mV vs. Li/Li$^+$*

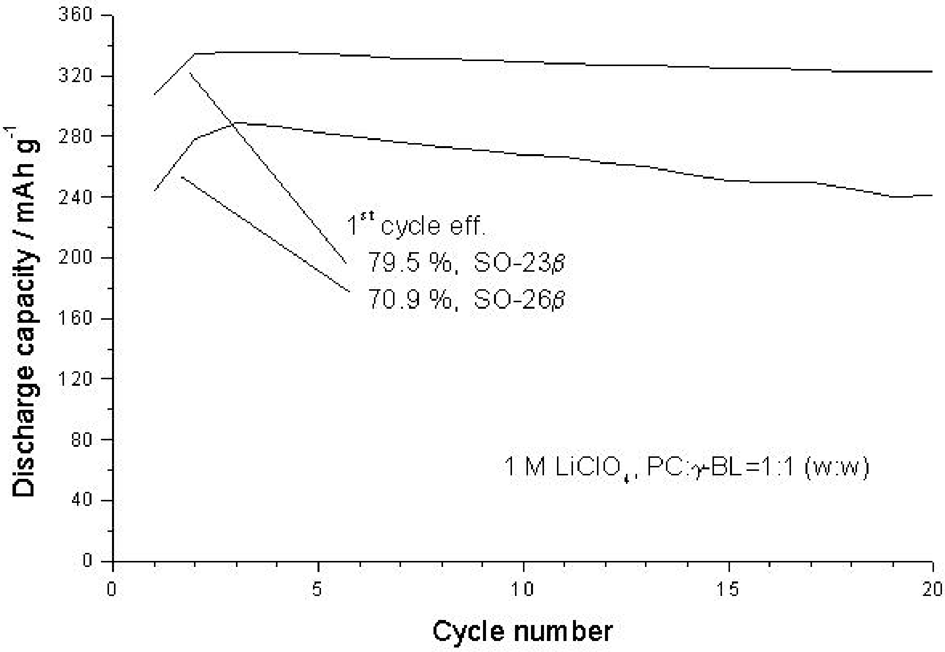

Fig. 2 *Progress of the discharge capacities of the rhombohedral graphites SO-23β and SO-26β. I_{charge}=-100 mA/g - U=24 mV vs. Li/Li$^+$, U=24 mV (=const.) for t=1 h, $I_{discharge}$=100 mA/g - U=1500 mV vs. Li/Li$^+$*

Conclusions

The results achieved show that the demands of an electrolyte like PC:γ-BL can be met up to a certain point by especially prepared graphites. Both classes of graphites have the potential to withstand the aggressiveness of such solvents.

Acknowledgements

Financial support by the Austrian Science Fund through the special research program “Electroactive Materials” is gratefully acknowledged.

References

1. J.R. Dahn, A.K. Sleigh, H. Shi, B.M. Way, W.J. Weydanz, J.N. Reimers, Q. Zhong, U. von Sacken, in: *Lithium Batteries – New Materials, Developments and Perspectives*, (G. Pistoia, Ed.) Elsevier, Amsterdam 1994, Ch. 1.
2. M. Winter, K.-C. Moeller, J. O. Besenhard, in: *Lithium Batteries, Science and Technology*, (G.-A. Nazri, G. Pistoia, Eds.) Kluwer, Boston, Dordrecht, New York, London, 2004.
3. B. Simon, S. Flandrois, K. Guerin, A. Fevier-Bouvier, I. Teulat, P. Biensan: J. Power Sources **81-82** (1999) 312-316.
4. S. Flandrois, K. Guerin: Mol. Cryst. Liq. Cryst. Sci. Technol. **340** (2000) 493-498