the occurrence of hysteresis in the potential profile during the lithium intercalation and deintercalation.

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## P9

## Effect of temperature on the performance of PMAN carbon anodes in 1 M $LiPF_6$/EC-DMC solution

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A considerable research effort is underway to utilize carbon and graphite materials as anodes for use in rechargeable lithium-ion cells. Graphitic materials can theoretically be charged to a composition of $LiC_6$ or 372 mAh $g^{-1}$. Some disordered carbons have been reported to reversibly store over 500 mAh $g^{-1}$.

During the first intercalation, however, solvent-reduction processes take place which irreversibly tie up part of the $Li^+$ in a passive film. The nature and composition of the film is a function of the type of solvent and supporting electrolyte used. It is desirable to minimize the extent of passive-film formation while maintaining a high reversible capacity for intercalation. To gain an understanding as to the kinetics of passive film formation, the intercalation process was examined as a function of temperature for carbons derived from a polymethacrylonitrile (PMAN)-divinylbenzene (DVB) copolymer. Both the irreversible and reversible capacities of the PMAN carbons were measured during galvanostatic cyclic experiments with 1 M $LiPF_6$/ethylene carbonate (EC)-dimethyl carbonate solution between 2 V and 0.01 V versus $Li/Li^+$ at temperatures of 5, 21 and 35°C. Cyclic voltammetric experiments between 3 V and 0.01 V were used to obtain supplemental information. Complex impedance spectra were taken as a function of voltage during intercalation to derive kinetic information of the intercalation and passive-film processes.

## P10

## Bismuth compounds as cathodic material for lithium accumulators

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Several groups of bismuth-containing oxide compounds (BCOC) were investigated to use as cathodic materials in lithium accumulators. Galvanostatic characteristics of composite BCOC-based electrodes have been obtained in PC, DME/1 M $LiClO_4$ electrolyte.

$BiXO_3$ (X = Eu, Sm) compounds have been assigned to the first group of BCOCs investigated.

The OCV of $Li/BiXO_3$ is 3.1 to 3.2 V. During cycling at a current density of 2 mA $cm^{-2}$ for six cycles, the following specific discharge capacities (Ah $kg^{-1}$) were obtained:

| | Cycle number | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| $BiEuO_3$ | 145 | 140 | 130 | 100 | 75 | 76 |
| $BiSmO_3$ | 320 | 315 | 200 | 158 | 140 | 148 |

At the first cycle of this BCOC group, the discharge curve is characterised by the voltage plateau of 1.7–1.4 V which increased up to 2.1–2.0 V in the subsequent cycles.

In the second group of BCOC, Aurivillius [1,2] phases, $Li/Bi_4Ti_3O_{12}$ and $Bi_4V_2O_{11}$ have been investigated. On discharge at 1 mA $cm^{-2}$ to 1.1 V, on the first cycle, bismuth titanate gave 325 Ah $kg^{-1}$ and 490 Wh $kg^{-1}$. During the next three cycles, capacity dropped to 175, 180 and 170 Ah $kg^{-1}$, over the voltage range 4 to 1.1 V.

$Bi_4V_2O_{11}$ was also investigated in monocrystalline form. The lithium/bismuth vanadate has the following characteristics: OCV = 3.1 V. Plateau voltage on first discharge at 0.1 mA $cm^{-2}$ was 1.8 V and the capacity to 1.1 V was 390 Ah $kg^{-1}$. Capacity decreased with cycling (Ah $kg^{-1}$). 2nd: 241, 3rd: 175, 4th: 108, 5th: 102, 6th: 103.

In the third group investigated, BCOC was a mixture of $PbBi_2O_3 + Bi_4Ti_2O_3$. The OCV was 3.1 to 3.15 V and capacity 575 Ah $kg^{-1}$ at 0.1 mA $cm^{-2}$ down to 1.1 V, or 260 Ah $kg^{-1}$ to 1.5 V.

These first results are encouraging. For practical accumulators, more investigations are necessary.

### References

[1] B. Aurivillius, *Ark. Kemi.*, (1949) 463.
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## P11

## Modelling and optimization of the parameters of the lithium/nonaqueous electrolyte interface in high energy power sources

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The problem of passivating film formation on lithium surfaces and the influence of the properties of this film is of