

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<sub>6</sub>/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<sub>6</sub> or 372 mAh g<sup>-1</sup>. Some disordered carbons have been reported to reversibly store over 500 mAh g<sup>-1</sup>.

During the first intercalation, however, solvent-reduction processes take place which irreversibly tie up part of the Li<sup>+</sup> 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<sub>6</sub>/ethylene carbonate (EC)-dimethyl carbonate solution between 2 V and 0.01 V versus Li/Li<sup>+</sup> 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<sub>4</sub> electrolyte.

BiXO<sub>3</sub> (X = Eu, Sm) compounds have been assigned to the first group of BCOCs investigated.

The OCV of Li/BiXO<sub>3</sub> is 3.1 to 3.2 V. During cycling at a current density of 2 mA cm<sup>-2</sup> for six cycles, the following specific discharge capacities (Ah kg<sup>-1</sup>) were obtained:

	Cycle number					
	1	2	3	4	5	6
BiEuO <sub>3</sub>	145	140	130	100	75	76
BiSmO <sub>3</sub>	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<sub>4</sub>Ti<sub>3</sub>O<sub>12</sub> and Bi<sub>4</sub>V<sub>2</sub>O<sub>11</sub> have been investigated. On discharge at 1 mA cm<sup>-2</sup> to 1.1 V, on the first cycle, bismuth titanate gave 325 Ah kg<sup>-1</sup> and 490 Wh kg<sup>-1</sup>. During the next three cycles, capacity dropped to 175, 180 and 170 Ah kg<sup>-1</sup>, over the voltage range 4 to 1.1 V.

Bi<sub>4</sub>V<sub>2</sub>O<sub>11</sub> 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<sup>-2</sup> was 1.8 V and the capacity to 1.1 V was 390 Ah kg<sup>-1</sup>. Capacity decreased with cycling (Ah kg<sup>-1</sup>). 2nd: 241, 3rd: 175, 4th: 108, 5th: 102, 6th: 103.

In the third group investigated, BCOC was a mixture of PbBi<sub>2</sub>O<sub>3</sub> + Bi<sub>4</sub>Ti<sub>2</sub>O<sub>3</sub>. The OCV was 3.1 to 3.15 V and capacity 575 Ah kg<sup>-1</sup> at 0.1 mA cm<sup>-2</sup> down to 1.1 V, or 260 Ah kg<sup>-1</sup> to 1.5 V.

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

## References

- [1] B. Aurivillius, *Ark. Kemi.*, (1949) 463.
- [2] B. Aurivillius, *Ark. Kemi.*, (1949) 499.

## 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