NEW HIGH PACKING NATURAL GRAPHITE FOR THE LI-ION BATTERIES WITH INCREASED ENERGY DENSITY CHARACTERISTICS

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Introduction

Superior Graphite Co. has recently developed a series of advanced carbonaceous products for application as negative electrode active materials in the high power and high capacity Li-Ion batteries. This presentation is aimed to introduce one of these new grades. Its tentative commercial name is SL-25. The material has been designed for the high capacity battery application.

Results and Discussion

An SEM of SL-25 can be seen at Fig. 1. One of unique features of this grade is its high packing density, which currently exceeds packing density of most graphitized cokes. This has been achieved by altering graphite's particle size and morphology, while maintaining properties, which are responsible for near theoretical electrochemical performance.

The grade has been manufactured from the natural flake graphite precursor, which has some recognized advantages over its graphitized synthetic counterparts. Such advantages comprise readily availability of the raw feed from the mines worldwide and intrinsically high crystallinity of $d_{002}\approx3.35$Å (interlayer spacing). We have shown before[1] that natural graphite having a certain degree of purity (99.9% C and up) and the estimated hexagonal / rhombohedral phases ratio of below 9, offers significantly higher reversible capacity over the graphitized synthetic and mesophase carbons (as seen upon cycling in the Li-Ion batteries).

The cycling data obtained for SL-25 supports the above-mentioned theory. Fig. 2 shows a stable continuous cycling, which, as authors believe, has been achieved by solving the lack of adhesion problem, a typical issue with other natural graphites. Fig. 3 shows galvanostatic charge-discharge curves for SL-25 at C/10 rate. Even at this relatively high for the SEI film formation rate, we have observed only 8.8 % of the irreversible capacity loss, followed by the stable reversible capacity of around 358 mAh/g. C/20 formation rate resulted in near theoretical reversible capacity with this carbon.

The table shows galvanostatic cycling results obtained at C/10 and C/3 rates at two different final electrode densities: 1.4 g/cc (typically used value[2]) and 1.7 g/cc. One can see that at both densities, SL-25 noticeable outperforms control of similar size distribution (MCMB-2528).

Table. Electrochemical Results vs Electrode Density.

	MCMB 2528	Natural Graphite SL-25	
Calendared electrode density, g/cc	1.4	1.4	1.7
Reversible Capacity @ C/10, mAh/g	310	353	352
Irreversible capacity loss, %	7	8.6	9
Reversible capacity @ C/3, mAh/g	260	308	285

Conclusion

The reported unique property of SL-25 to be able to efficiently work at the electrode density values of up to 1.7 g/cc may allow realizing up to 40% improvement of the negative electrode energy density, which is one of the most important volumetric characteristics of a battery[3].

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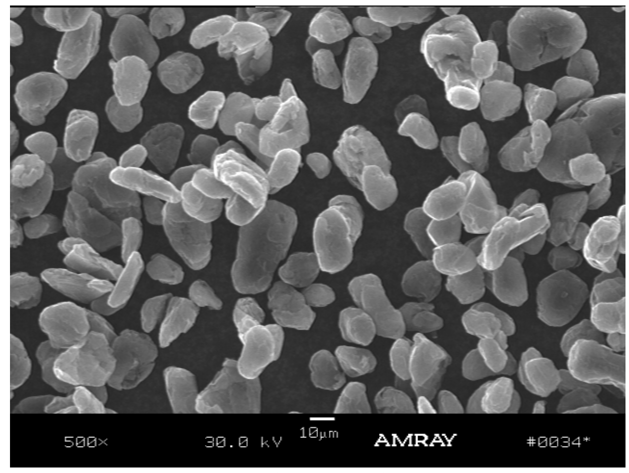

Fig. 1. SEM images of the purified natural graphite grade SL-25 (D_{50}<25 μm; bulk density > 0.55 g/cc).

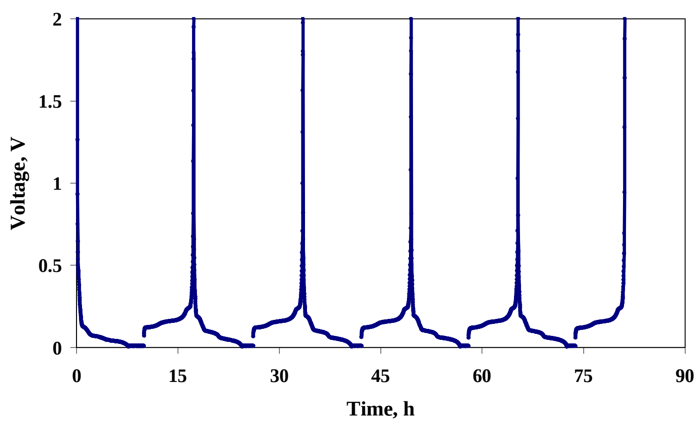

Fig. 2. Galvanostatic cycling of graphite SL-25 (first five cycles shown). Two-electrode cell with Li as a counter electrode; Electrolyte: 1M $LiPF_6$ in EC:DMC; Intercalation-deintercalation current is approx. C/10.

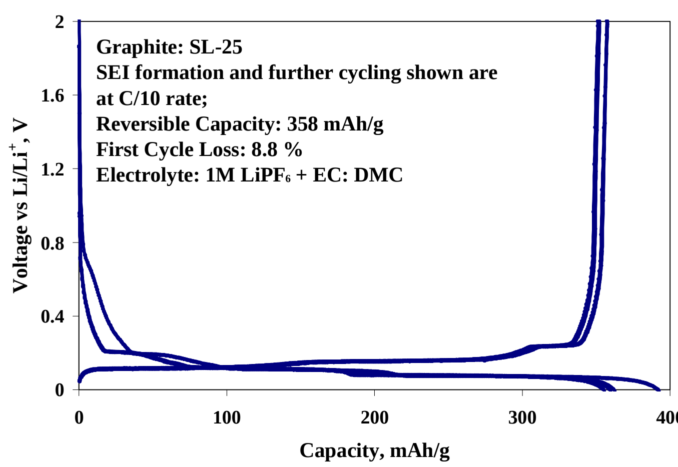

Fig. 3. Galvanostatic cycling of SL-25 @ C/10 rate Two-electrode cell with Li foil as a counter electrode. Electrolyte: 1M $LiPF_6$ in EC:DMC.

References

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Acknowledgement

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