Li_2CO_3-coated Sri Lankan Vein Graphite Electrode for Rechargeable Lithium-ion Battery

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Introduction

High quality vein graphite, containing 95-99% of pure carbon in Sri Lanka has been identified as promising candidate as anode material in lithium ion rechargeable battery. Purification and mild oxidation have been widely used to enhance the property of the vein graphite as anode material (Balasooriya et al., 2007; Amaraweera et al., 2013). However, alkali carbonates coating which are identified as cost effective and nontoxic approach for the surface modification have not been investigated for vein graphite in Sri Lanka (Komaba et al., 2008; Zhang et al., 2003). Therefore, present work is aimed to develop low cost anode material based on Li_2CO_3 coating of purified vein graphite.

Methodology

Purified vein graphite powder less than 53µm (<53 µm) was used for this study (Amaraweera et al., 2013). Graphite powder were added into an agate motor and milled for about 2 hours by adding aqueous $Li_2CO_3$to ensurethat the graphite was completely witted. Then the surrey was dried in vacuum at 100 ^{0}C. The modification of the graphite mixture was characterized by FTIR Spectroscopy D.C conductivity of graphite powder and sheet conductivity of graphite electrode was measured by four-probe and VanderPauw, methods respectively.

Results and Discussion

Fourier Transform Infrared (FTIR) spectra of the Li_2CO_3 coated KSSF (KahatagahaShiny-Slippery-Fibrous) graphite is shown in Figure 1. In the FTIR spectra, the broad band between 3500 and 3100 cm^{-1} and the band at 1620 cm^{-1} are attributed to the bending mode of the molecular water. The band at 2330 cm^{-1} can be assigned to the CO_2 in the gas phase physically adsorbed on the material surface. Doublet band at 2921 and 2850 cm^{-1} are appear in treated and untreated graphite which is corresponding to the presence of aliphatic C-H bonds. Vibrational bands correspond to $\nu_{C=O}$ stretching at 1720-1680 cm^{-1}, ν_{O-H} stretching at 1360 cm^{-1}and ν_{C-O} stretching at 1260-1000 cm^{-1} are predominant on the purified graphite surface. Those bands reflect the surface active species on the edge plane of the graphite. However, intensity of those bands reduced after Li_2CO_3 treatment may be due to precipitation of Li_2CO_3 on those active sites. The IR spectrum for the Li_2CO_3 coated graphite shows a band located at between 860 and 870 cm^{-1}and another broad one between 1550 and 1400 cm^{-1}, which corresponds to the IR signature of Li_2CO_3, thus indicating a copious amount of Li_2CO_3 are coated on the surface of graphite.

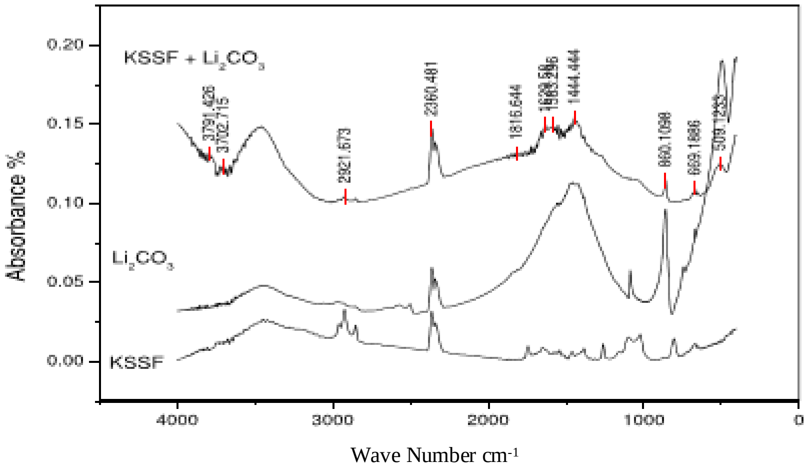

Figure 1. FTIR spectra (KBr Pellets, Absorbance mode) of the KSSF,$Li_2CO_3$and Li_2CO_3 coated KSSF graphite.

Table 1. The DC electrical conductivity of treated and untreated graphite powder and sheet conductivity of graphite electrodes.

Structural Type	DC conductivity (S/cm) (at 25 °C)		Sheet conductivity S/cm) (at 25 °C)	
	Purified Graphite	Li_2CO_3 Coated Graphite	Purified Graphite	Li_2CO_3 Coated Graphite
KSSF	4.56	3.07	0.97	1.09
KCFR	4.14	4.05	0.71	1.04
BSSF	2.90	2.03	0.28	0.97
BCFR	3.06	2.63	1.79	1.82

Note KSSF= Kahatagaha Shiny- Slippery-Fibrous graphite, KCFR = Kahatagaha Coarse Fakes of Radial graphite, BSSF = Bogala Shiny- Slippery-Fibrous graphite, BCFR = Bogala Coarse Fakes of Radial graphite.

The DC electrical conductivity of treated and untreated graphite powder and sheet conductivity of graphite electrode prepared by untreated graphite powder are summarized in Table 1.DC electrical conductivity measurements of the graphite powders and the sheet conductivity of the graphite electrodes show sufficient electrical conductivity value for the anode application. Li_2CO_3 coating has not caused any adverse effect on the electronic properties of graphite. The sheet conductivity of graphite electrodes are lower than the DC conductivity of graphite pellets due to the effect of binder, poly vinylidene fluoride used for the preparation of electrodes.

Conclusions

The D.C. electrical conductivity of graphite powders and sheet conductivity of graphite electrode show the sufficiently sufficient electrical conductivity value for the anode application in lithium ion rechargeable batteries. Further, D.C electrical conductivity of the Li_2CO_3 coated graphite implies that the coating has not caused any adverse effect on the electronic properties of graphite. The FTIR spectrum of Li_2CO_3 coated graphite shows evidence modification of the surface chemistry of the graphite with respect to the unmodified graphite. Therefore, Li_2CO_3can be introduced as cost effective, non-toxic and eco-friendly approach to modify the vein graphite in Sri Lanka for anode material for lithium ion rechargeable batteries.

References

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