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Purification of Vein Graphite by Alkali Roasting for Anode Material in Lithium Ion Batteries

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Introduction

Unique vein graphite deposits with highly crystallized and high purity graphite are present in the mineralization zone of the central highlands of Sri Lanka This graphite has been identified as a potential candidate for the lithium ion rechargeable batteries (Balasooriya*et al.,* 2007). Recent attention has been made towards the purification of vein graphite in order to prevent the anode ageing and decomposition of the electrolyte in lithium ion batteries (Amaraweera et al., 2013). Alkali roasting for purification of graphite has found to be a very effective method to remove sulfide and silicate impurities at low temperatures (Lu et al., 2002). Therefore, this study focused on studying the effectiveness of alkali roasting for the purification of vein graphite in Sri Lanka

Methodology

Graphite powder (<53 μm) from Needle Platy Graphite (NPG) and Shiny Slippery Fibrous (SSF) morphological types from Bogala and Kahatagaha mines were used for this study. The graphite was treated in aqueous solutions containing 5, 10, 15, 20, 25, 30 and 35 vol. % NaOH (Solid: liquid, 1:2) separately and roasted at 250 ^{0}C under air for one hour. Then, the roasted sample was acid leached in 10 vol. % H_2SO_4. After that, the solid was filtered, washed to neutral and vacuum dried at 100 ^{0}C for 15 hours. Minimum concentrations of NaOH for the purity enhancement were identified for each graphite type. Roasting treatments were repeated at 150 ^{0}C, 200 ^{0}C, and 300 ^{0}C, using the data obtained previously to identify the effect of roasting temperature on purity enhancement.

Carbon percentages of the treated graphite samples and untreated graphite samples were determined by heat treating at 950 ^{0}C for 3 hours in Muffle Furnace, according to ASTM – C 561 and weighing the residues. Pellets of treated and untreated graphite powder (D =12 mm and L = 5 mm) prepared by cold uniaxial pressing at 100 Mpa were used to measure D.C conductivity by four-probe method at room temperature.

Results and Discussion

The graphs presented in Figure 1 show the effect of NaOH concentration on upgrading the carbon content of different structural types of vein graphite from Bogala and Kahatagaha mines. These results suggest a strong dependence of final purity on HCl concentration and the initial purity. Initial purity of the morphological varieties from Bogala mine were 94.65% (BNPG), and 98.41% (BSSF). Carbon percentages of above Bogala variety were upgraded to 99.29% and 99.92% respectively after the alkali roasting with25% NaOH solution at 250 ^{0}C. Similarly, initial purity of the morphological varieties from Kahatagaha mine were 95.04% (KNPG), and 99.14% (KSSF). Carbon percentages of above Katatagaha variety were upgraded to to 99.33% and 99.96% respectively after the alkali roasting with20% NaOH solution at 250 ^{0}C.

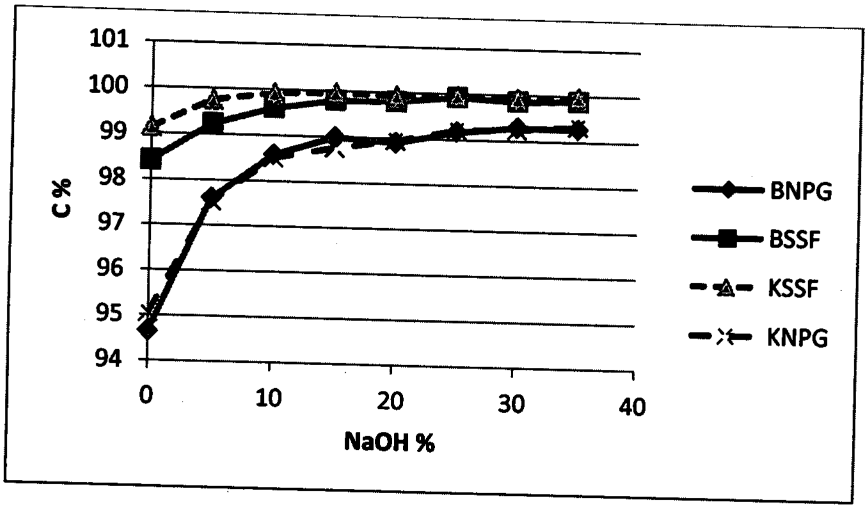

Figure 1. Effect of NaOH concentration on upgrading the carbon content in vein graphite

Table 1 compares the effect of roasting temperature for upgrading the carbon content of graphite. It was clearly seen that the optimum roasting temperature for the treatment is in between 250 and 300 ^{0}C.

Table 1. Effect of roasting temperature on upgrading the carbon content in vein graphite

Roasting Temperature ^{0}C	Carbon Percentage of Different Morphological Types of Graphite after the Alkali Roasting			
	BNPG	BSSF	KNPG	KSSF
150	98.68	99.63	98.10	99.59
200	98.76	99.68	98.38	99.63
250	99.16	99.92	99.23	99.95
300	99.61	99.76	99.45	99.85
150	98.68	99.63	98.10	99.59

The DC electrical conductivity of treated and untreated graphite powders are summarized in Table 2. DC electrical conductivity measurements of the graphite powders show the sufficient electrical conductivity value for the anode application.

Table 2. The DC electrical conductivity of treated and untreated graphite powder.

Morphological Types of Graphite	DC conductivity (S/cm) (at 25 ^{0}C)	
	Raw Graphite	Purified Graphite
BNPG	2.8	2.1
BSSF	2.9	2.5
KSSF	2.8	3.2
KNPG	3.4	3.1

Conclusions

This study revealed that the impurities in Sri Lankan vein graphite can be effectively removed by alkali roasting treatment depending on the initial purity of different structural varieties. DC electrical conductivity data of treated graphite suggest that vein graphite from Bogala and Kahatagaha-Kolongala mines are potential candidate as active anode materials for lithium ion rechargeable batteries.

References

Amaraweera, T.H.N.G., Balasooriya, N.W.B., Wijayasinghe, H.W.M.A.C., Attanayake, A.N.B., Dissanayake, M.A.K.L., 2013. Purity Enhancement of Sri Lankan Vein Graphite for Lithium - ion Rechargeable Battery Anode, Proceedings to 29th Technical Sessions of Geological Society of Sri Lanka, 101-104.

Balasooriya, N.W.B., Touzain,Ph., Bandaranayake, P.W.S.K., 2007. Capacity improvement of mechanically and chemically treated Sri Lanka natural graphite as an anode material in Li-ion batteries, Ionics, 13, 305-309.

Lu, X.J., Forssberg, E., 2002. Preparation of high-purity and low-sulphur graphite from Woxna fine graphite concentrate by alkali roasting, Minerals Engineering, 15, 755–757.