

Structural Characteristics of Natural Graphite and Synthetic Graphite

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Introduction

Sri Lanka is famous for highly crystalline natural vein graphite. Bogala and Kahatagaha – Kolongaha are main graphite mines which are situated in the central highlands. Sri Lankan natural graphite is found in various morphologies with different structural and physical characteristics such as flake, plate and fibrous graphite. Sri Lanka graphite has high purity carbon.

At present graphite industry in Sri Lanka is mainly limited for pencil productions. But in other countries which are producing graphite with high quality, motivate to conduct worthy industries. China, Mexico, Canada, Brazil and Madagascar are other countries which produce graphite for world market. Sri Lanka was top of the leading supplier of natural graphite to the world market and fulfilled the 20%-35% of the total world production. High labor cost, expensive deep mining methods and high mining cost are main problems to decay production of graphite. Therefore currently Sri Lankan graphite is unable to conflict in world market. As well as the lack of modern skills are main detriments for graphite industry.

Currently synthetic graphite is used instead of natural graphite to produce different kinds of products. The synthetic graphite is known as artificial, manufactured or electrographites. A carbon product (100% pure carbon) has been subject to a further stage of heat treatment at a temperature about 2400°C. In the main, synthetic graphite is used for electrodes in lithium ion batteries, coatings, conductive fillers, rubber and plastic compounds, foundry etc. However, in Sri Lanka, there are limited work has been done to study structural characteristics of graphite. Therefore, Sri Lankan natural graphite is unable to use for some industries like electrochemical application industries. Most of graphite used for applications as powder form. As a result, rhombohedral content is increasing gradually. Certain applications need rhombohedral phases rather than hexagonal phase.

Materials and Methods

X-ray diffraction (XRD) techniques have been widely applied for the structure characterization of carbon materials. XRD data of Bogala fibrous graphite, Bogala platy graphite, Kolongaha fibrous graphite, Kolongaha platy graphite, Madagascar synthetic graphite and Timcal synthetic graphite were subjected to analyzing. All XRD data are belong to Philips x-Ray generator using Cu K α radiation and wave length $\lambda=1.5406 \text{ \AA}$. The diffraction angle (2θ) could be varied from 5° to 90° . The amount of rhombohedral percentage of graphite was calculated from X-ray diffractogramme which were plotted using XRD data by measuring height of the peaks of hexagonal (101) and rhombohedral (101) reflections. ASTM data were used to identify the correct peaks due to d- interlayer distances values. Crystallographic parameters (a and c) are calculated using the hexagonal crystallographic formula. The lengths of coherence (L_a and L_c) of graphite can be calculated using XRD data. The L_c values are calculated based on the d_{002} diffractionline, using the

Sherrer's formula while the L_a values are calculated with the d_{100} diffraction line using the Warren's formula. Both calculations were done for untreated and mechanical treated (25hrs. and 50 hrs. ball milled) natural and synthetic graphite. All the results were compared with reference data. The different chemical impurities in Sri Lanka natural graphite were analyzed qualitatively using PCPDFWIN software for XRD data.

Results and Discussion

Rhombohedral content of untreated and mechanical treated natural and synthetic graphite shows significant difference (Figure 2). Rhombohedral percentage is higher in treated graphite (Table 1).

Table 1: Variation of Rhombohedral content

Type of the graphite	Untreated (%)	Grinded time	
		25 hrs (%)	50 hrs (%)
Bogala Fibrous	43	58	57
Bogala Platy	52	67	50
Kolongaha Fibrous	42	53	43
Kolongaha- Platy	47	55	49
Madagaskar Synthetic	45	-	-
Timcal Synthetic	55	-	-

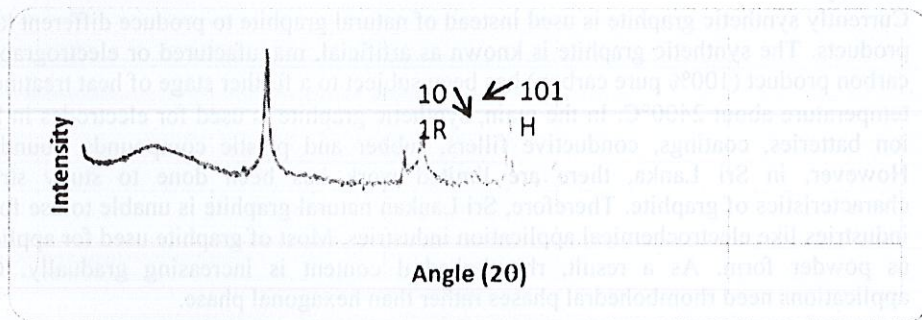


Figure: 1. X-ray diffractogramme of Bogala Fibrous untreated graphite

The average crystallographic parameter, 'c' is 6.732 Å and 'a' is 2.465 Å, for untreated natural graphite (Table 2). According to the diffraction line of d_{100} the L_a average values of natural graphite vary between 63nm and 160nm. The L_c values of natural graphite vary between 40nm and 70 nm with respect to d_{002} diffraction line.

Table 2: Calculated crystallographic parameters values for untreated natural graphite

Graphite type	Parameter	
	a (Å)	c (Å)
Bogala Fibrous	2.469	6.73
Bogala platy	2.461	6.725
Kolongaha fibrous	2.464	6.737
Kolongaha platy	2.464	6.751
Madagascar synthetic	2.463	6.725
Timcal synthetic	2.467	6.726

Fe, S, Cu, Fe₂O₃, MgO and Al₂O₃ were identified as major impurities in natural graphite.

Conclusion

The rhombohedral content is higher in treated natural graphite than untreated natural graphite. Sri Lanka natural graphite has high purity as well. Therefore natural graphite can be utilized for profitable applications such as electrochemical opportunities for intercalation.

References

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