

PHYSICAL AND CHEMICAL PURIFICATION OF SRI LANKAN FLAKE GRAPHITE AND VEIN GRAPHITE

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ABSTRACT

The vein graphite deposits of Sri Lanka, located in a Precambrian high-grade metamorphic terrain dominated by granulite-facies rocks. Vein graphite becomes more attractive in Sri Lankan mineral index due to high purity, extensive mineralization with large reserves, high crystallinity and mode of occurrence. The study tends to evaluate the potentiality of purifying Sri Lankan flake graphite by both physical and chemical purification methods as well as compare the purity enhancement with Sri Lankan vein graphite towards the advanced applications.

Keywords: Chemical Purification, Flake Graphite, Vein Graphite

INTRODUCTION

Naturally occurring graphite typically classified into three forms; flake graphite, vein graphite and amorphous graphite. Sri Lanka is endowed with high quality vein graphite as well as considerable reserves of flake graphite. Flake graphite occurs as isolated, flat plate-like particles disseminated in lenses or pockets in metamorphic rocks. Flake graphite deposits occur at the South Western region of Sri Lanka. The vein graphite deposits of Sri Lanka, located in a Precambrian high-grade metamorphic terrain dominated by granulite-facies rocks. Vein graphite becomes more attractive in Sri Lankan mineral index due to high purity (about 95-99 % of pure carbon), extensive mineralization with large reserves, high crystallinity and mode of occurrence [1, 2].

Purification of graphite commonly utilized both physical and chemical techniques. Froth flotation is a best physical purification technique for the graphite that utilizes the difference in surface properties of the valuable minerals and gangue minerals. Graphite is inherently having a non-polar surface that does not readily attach to the water dipoles. Therefore graphite can be effectively collected into the froth [3]. Most of the chemical purification techniques are based on acid treatments. Alkali Roasting is one of the effective chemical methods that are able to remove sulfide and silicate impurities from graphite [4-6].

Many of the reputed graphite supplying countries have flake graphite with low initial purity. However they have upgraded flake graphite to high tech applications such as electrodes, refractories, lubricants and other electrochemical applications. Even though Sri Lankan vein graphite were studied in many aspects, limited attention was drawn to study the distribution, chemistry, origin and geological setting of flake graphite [7-9].

Therefore present study tend to evaluate the potentiality of purifying Sri Lankan flake graphite by both physical and chemical purification methods as well as compare the purity enhancement with Sri Lankan vein graphite towards the advance applications.

METHODOLOGY

All the vein graphite samples were collected form Kahatagaha Kolongaha mine and separated into four morphological verities by visual observations. Flake graphite samples were Samples were collected from two abandoned mines in Pasyala area (Kaluaggala and Wawehena).

Initially all the samples were crushed by laboratory disk mill and two size fractions (<75 μm and <53 μm) separated by mechanical sieving. Selected two verities of vein graphite (needle platy graphite and shiny slippery fibrous graphite) and two samples of flake graphite from different locations were subjected to froth flotation. All the samples in powder form with <75 μm particle size. Phenol was added to mixture to enhance the effectiveness of froth formation. Collected froth was washed and dried at 60 °C for 24 hours. Froth floated vein and flake graphite powder samples (particle size <53 μm) were utilized in alkali roasting method. Initially 3g of each sample were treated with NaOH separately and roasted under air. Then roasted samples were acid-leached in 10 vol. % H_2SO_4 [4]. After the treatment each sample was thoroughly washed to neutral and vacuum dried.

Both raw and treated samples were characterized by ASTM - 561 method for carbon content and X-ray Diffraction techniques (XRD) for phase analysis. The electrical characterization was performed on the dense graphite pellets by the d.c. four probe technique.

RESULTS AND DISCUSSION

Table 1 show the purity enhancement of the two selected flake graphite samples in different locations. Both physical and chemical methods were able to effectively upgrade the purity, compared to the initial purity. As a series of purification froth flotation able enhanced purity around 55% and alkali roasting around 34%.

Table 1: C% of raw and purified flake graphite samples by froth flotation and alkali roasting

Sample No	Initial Purity	After Froth Flotation	After Alkali Roasting
Samples from Kaluaggala	27.3%	60.0%	95.6%
Samples from Wawehena	29.6%	67.4%	97.9%

Table 2 has the purity enhancement of two selected Sri Lankan vein graphite by alkali roasting followed by the froth flotation. For the vein graphite, froth flotation was not able to provide sufficient purity enhancement. However as a chemical method alkali roasting was successful with the purity upgrading of vein graphite.

Table 2: C% of raw and purified vein graphite samples by froth flotation and alkali roasting

Sample No	Initial Purity	After Froth Flotation	After Alkali Roasting
NPG	99.60%	99.67%	99.95
SSF	97.31%	97.32%	99.89

Figure 1 composed of the X-ray diffratograms of initial and after froth flotation of flake graphite. It clearly illustrate that many of impurity inclusions was removed after the froth flotation. Moreover some of impurity mineral phases such as quartz and pyrites still remain in the matrix

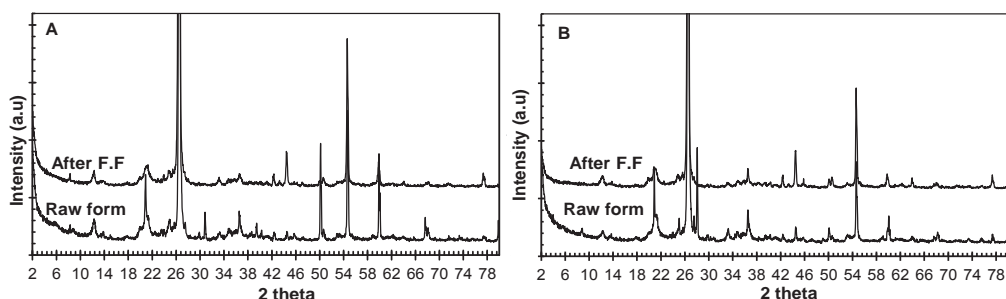


Figure 01: X-ray diffratograms of raw and froth floated flake graphite A- samples from Kaluaggala, B-samples from Waweheha

Figure 2 composed X-ray diffratograms of initial and purified needle platy and shiny slippery fibrous vein graphite varieties. After alkali roasting treatment XRD graphs of vein graphite illustrate only the phases corresponding to the crystalline graphite. Further chemical treatment did not affect for the graphite structure.

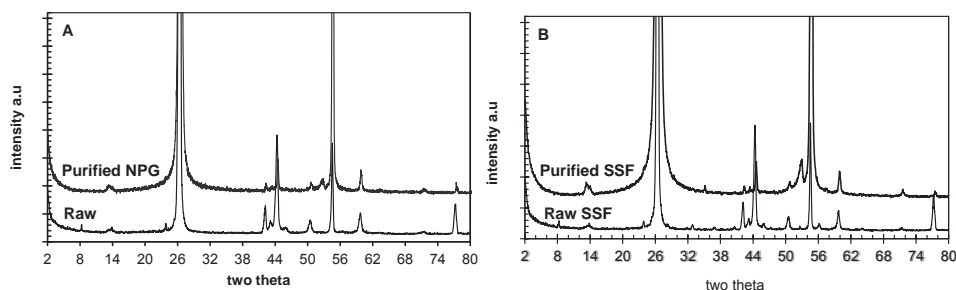


Figure 02: X-ray diffratograms of raw and alkali roasted vein graphite A- NPG vein graphite variety, B-SSF vein graphite variety

The electrical conductivity for raw and purified samples of both vein graphite and flake graphite shown in table 03. Electrical conductivity decreased with purification for both vein graphite and flake graphite. Notably drastic decrement in electrical conductivity can be observed in flake graphite. Inherently graphite has semi-conducting behavior but impurity mineral in raw form tend to increase the electrical conductivity of graphite.

Table 3: D.C electrical conductivity of raw and treated graphite varieties at RT (25 °C)

Sample type	Sample ID	Conductivity of the raw form (Scm ⁻¹)	Conductivity after forth flotation and alkali roasting (Scm ⁻¹)
Flake Graphite	Samples from Kaluaggala	38.2	9.4
	Samples from Waweheha	16.6	8.2
Vein Graphite	Needle platy graphite	7.2	4.8
	Shiny slippery fibrous graphite	7.3	5.2

CONCLUSION

Vein graphite possesses high initial carbon content around 97-99% compared with flake graphite. As a physical purification method froth flotation was not able provide sufficient purity enhancement for the vein graphite. It may due to the impurities present as sulfide and transition metals in trace levels intercalated to the crystal structure. However froth flotation was successful with flake graphite and provide adequate purity enhancement around 55%. Moreover alkali roasting was able to enhance the purity over 95 % of carbon content for both flake graphite and vein graphite followed by the froth flotation. Specially vein graphite reached up to 99.9% of carbon. Electrical conductivity has a decreasing pattern due to the removal of impurity minerals with the purification. However electrical conductivity exists in semi-conductivity range after both physical and chemical purification.

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