

Purification of Surface Graphite from Passyala, Sri Lanka

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Introduction

Flake graphite occurs as isolated, flat plate-like particles disseminated in lenses or pockets in metamorphic rocks. Less frequently it occurs in massive accumulations in veins. This is the geologically most common variety of natural graphite. Surface graphite (flake graphite) deposits occur at South Western region of Sri Lanka. There were large number of shallow pits in Sri Lanka had historically been sunk in to the weathered rock or top soil and believed more than 2500 graphite pits and mines were located in the west and central highlands. Graphite exploration from Matugama, Warakapola, Passyala and Deniyaya are in progress as new sites. Even though there are various studies on Sri Lankan vein graphite, limited attention was drawn to study the distribution, chemistry, origin and geology setting of surface graphite deposits in Sri Lanka. (Wijayananda N.P.,1987).Froth Flotation is versatile mineral processing technique, that utilizes the difference in surface properties of the valuable minerals and the unwanted gangue minerals to achieve specific separations from complex ores. Graphite have non-polar surface that do not readily attach to the water dipoles. Therefore in the separation graphite can be effectively collected into the froth. (Wills B.A.,2006). considering the chemical purification, recent studies on flake graphite with alkali roasting proven that the purity can be upgraded over 95%. (Lu, X.J., *et al*,2002) Present research was aimed to study the purification of Sri Lankan flake graphite by using both chemical and physical purification techniques.

Materials and methodology

Initially collected samples were crushed into chips and prepared powder samples (<250 µm) for both sample no-01(taken from Wawehehena mine) and 02 (taken for Kaluaggala mine). 200g from each samples were taken into froth flotation. Separated froth was washed to remove the effect of phenol and dried at 60 °C for 24 hours.

3g from each graphite sample was take into alkali roasting, mixed with 10,20,30,40,50,60 vol. % NaOH (solid: liquid, 1:2) separately and roasted at 250 °C under air for one hour. The roasted sample was acid-leached in 10 vol. % H₂SO₄ and filtered. The residue was washed to neutral and vacuum dried at 100 °C for 15 hours. (Lu, X.J., *et al*,2002).Carbon percentage of graphite was determined according to ASTM - 561 and weighing the residues. Both initial and froth floated graphite matrix was characterized by Fourier Transform infrared (FTIR) spectrophotometer in 500 - 4000 cm⁻¹ region (Nicolet 6700). The electrical characterization was performed on the dense graphite pellets by four probe d.c. conductivity in air.

Results and discussion

Table - 4.1 shows the measured carbon content for both sample 01 and 02, before and after froth flotation. Froth flotation was able to achieve averagely 35% purity enhancement for the collected

flake graphite samples. Therefore it clearly evident that the forth flotation technique is much effective as an initial purification technique before moving to the chemical or any other purification method.

Table 4.1: Carbon Percentage of both sample 01 and 02, before and after froth flotation

Sample No	Initial purity	After froth flotation	Effective Enhancement from froth flotation
No -01	27.3%	60.0%	32.7%
No -02	29.6%	67.4%	37.8%

Figure - 1 shown comparative illustration of NaOH concentration Vs carbon percentage of sample no-1 (left) and sample no-02 (right) respectively. Sample no-01 could able to reach it maximum purity value 95.64% with 40% of NaOH but there is no gradual increment in carbon percentage with the increment of NaOH concentration. Though in sample no-02 there is an increment of purity enhancement and it seems to be matured after 40 % NaOH concentration. It marked the maximum purity 97.98% at 50% of NaOH concentration. Further increment of the NaOH concentration may not be significant.

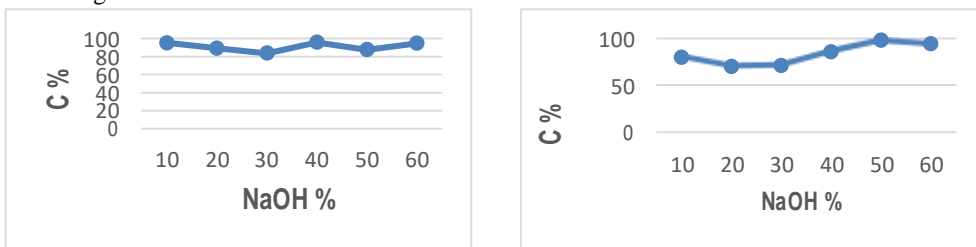


Figure - 1: Effect of NaOH

concentration on purity enhancement for sample no 01(left) and sample no-02(right), roasting at 250 °C

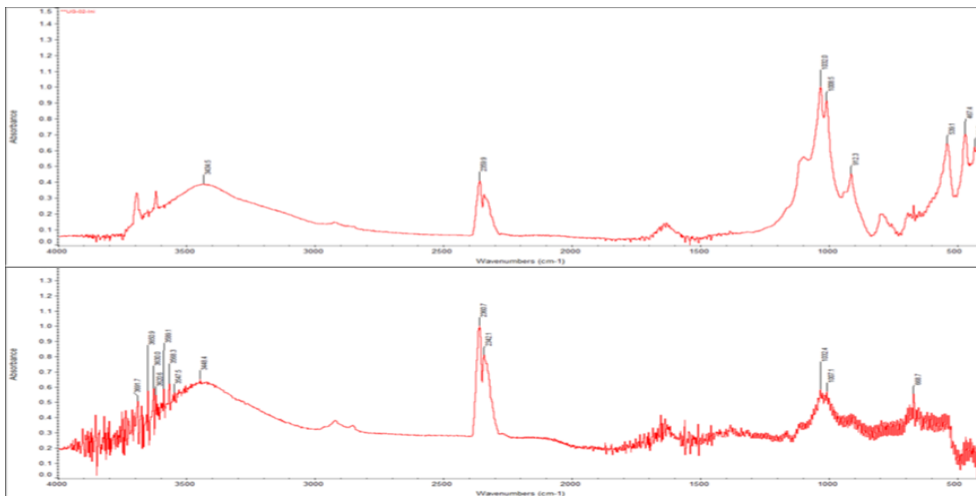


Figure – 2 - Fourier transform infrared spectroscopy-FTIR (KBr Pellets, Absorbance mode) curves for the sample no-01 (A) and sample no-02 (B) after froth flotation.

Figure-2 provide a comparative illustration of FTIR analysis for froth floated samples (for sample no-01 and 02). The broad band between 3500 and 3100 cm^{-1} and the band at $\sim 1620 \text{ cm}^{-1}$ are attributed to the bending mode of the molecular water. The doublet band at $\sim 2360 \text{ cm}^{-1}$ and 2342 cm^{-1} can be assigned as a characteristic band for graphite. When both sample 01 and 02 were in initial stage the mentioned characteristic band was suppressed. Though the FTIR curve after froth flotation evident significant presence of that particular band with a better absorption

The D.C. electrical conductivity details of graphite samples after froth flotation and purification are given in Table-2. Electrical conductivity of raw graphite samples was not measured because they have low carbon percentage and contained various impurities which can affect the electrical conductivity more than that of graphite in the sample such as weathered laterite soil.

Table – 02 D.C. electrical conductivity of graphite samples after froth flotation and purification.

Sample no	Initial purity	Conductivity after froth flotation / Scm^{-1}	Enhanced purity	Used NaOH concentration	Final conductivity / Scm^{-1}
01	27.3%	38.28	95.64%	40%	9.41
02	29.6%	16.68	97.98%	50%	8.28

Electrical conductivity values after the froth flotation were 38.28 Scm^{-1} for sample 01 and 16.68 Scm^{-1} for sample 02. These values are relatively high for graphite. These samples still contain significant amount of impurities which may be the reason for these high electrical conductivity values. Finally electrical conductivity values are relatively lower and vary around 9 Scm^{-1} . This clearly indicate that the alkali roasting could able remove the impurities which influenced the electrical conductivity and enhance the performance of flake graphite.

Conclusion

Carbon content analysis results shown that froth flotation is very much effective for the purity enhancement of flake graphite. As a chemical purification alkali roasting shown a profound effect on purity enhancement. Samples with lower initial purity shown good enhancement at 40-50 % NaOH concentration. Therefore it can be conclude that it is possible to purify low grade surface graphite (flake graphite) to obtain high purity graphite (<97% C) using both identified chemical and physical methods.

References

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