Performance Analysis of Structure on Natural Coal Materials

Thein Tun Linn[1] and Min Maung Maung[2]
[1]*Department of Physics, University of Monywa, Monywa, Sagaing Region, Myanmar and*
[2]*Department of Physics, University of Dawei, Dawei, Tanintharyi Region, Myanmar*
theintunlinn86@gmail.com, minaerchan@gmail.com

Abstract

The sample of coal mineral was synthesized by the modified Hummer's method. The element concentration of prepared coal sample was analyzed by Energy Dispersive X-ray Fluorescence (EDXRF) spectrometer. The structure characterization of prepared sample was indentified by X-ray Diffraction (XRD) technique. From the XRD result, it was shown that the Hexagonal structure and lattice parameter of 2.2407 Å for 'a' and 6.7691 Å for 'c'. This structure is transformed into like graphite structure. The room temperature dielectric constant measurement of coal sample with frequency range 1 kHz to 200 kHz was determined. The dielectric constant of sample decrease from 1 kHz to 50 kHz and nearly constant up to 200 kHz. The variation of coercive force (H_c) and remanence (B_r) have been investigated using B-H loops as a function of applied magnetic field. The room temperature magnetic hysteresis loop measurement demonstrated that the sample was soft magnetic nature.

***Keywords*:** Coal, modified Hummer's method, EDXRF, XRD, Dielectric constant, Hysteresis Loop

Introduction

Study on various non-renewable energy sources and enhancement of their fuel efficiency through different processes like chemical and biological means is a topic of continuing research. Many environmentalists see coal as inherently dirty. Coal minerals are considered objectionable due to the process as well as environmental problems.

Coal in its most common natural form is composed primarily of carbon consisting of decomposed and fossilized organic material from plants and animals that lived millions of years ago. Carbon derived from coal is becoming more important than wood and petroleum products as feedstock to make common products that society uses every day.

Carbon materials are attracting increasing attention due to the novelty of the associated physical properties and the potential applications in high-tech devices. Graphite is a natural mineral that consists of carbon. Carbon materials are widely used for electrodes in various electrochemical devices, such as batteries, supercapacitors, gas sensors and dye-sensitized solar cells.

In this present work, the coal mineral was obtained from Namma mine, Shan state. The powder sample was analyzed with X-ray diffraction (XRD) and EDXRF spectroscopy. The room temperature dielectric constant measurement with various frequency range was determined. Magnetization and demagnetization properties of the sample was specified by Permagraph L Technique.

Materials and Method

Sample Preparation

The samples were randomly handpicked from Namma coal field. It was crushed and ground in a pestle and mortar. And then, 1 g of coal sample was added to 25 ml of cooled (0°C) concentrated H_2SO_4.

Then, 3 g of $KMnO_4$ was added gradually with stirring and cooling. The mixture was then stirred at 35°C for 30 min. After that, 45 ml of distilled water was slowly added to cause an increase in temperature to 98°C, and the mixture was maintained at that temperature for 15 min. The reaction was terminated by adding 150 ml of distilled water followed by 10 ml of 30% H_2O_2 solution. The suspension was then repeatedly centrifuged and washed twice with 5% HCl solution and then repeatedly with water until sulfate could not be tested with barium chloride. The collected precipitate was dispersed in 450 ml water and sonicated for 2 hr. Then, the suspension was separated into the supernatant liquor and a golden colored residue by centrifugation at 5,000 rpm for 10 min. And then, the slurry was filtered using filter paper to remove the capture solution. The filtrates were dried at temperature of 60°C. Prepared sample was pressed by manual type pellet machine to be small circular-shaped pellet. The powder sample was prepared with XRD holder to determine the structure and lattice parameter. The obtained pellet sample was analyzed by EDXRF and Permagraph L.

Results and discussion

X – ray Powder Diffraction (XRD)

The structure characterization of prepared sample was indentified by X-ray Diffraction (XRD) technique. From the XRD result, it was shown that the Hexagonal structure and lattice parameter of 2.2407 Å for 'a' and 6.7691 Å for 'c'. This structure is transformed into like graphite structure. The intensity and sharpness of the peaks give an indication of the degree of order compared to that of a graphite crystal. The XRD pattern of prepared coal powder was shown in Figure 1.

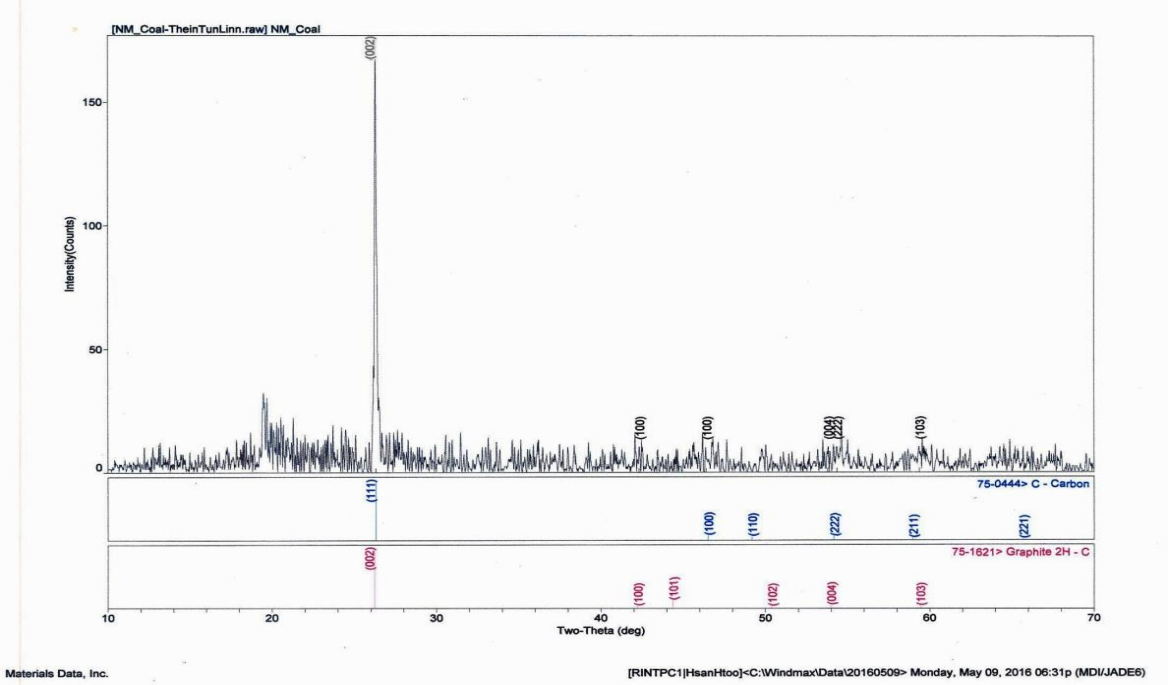

Figure 1 : The XRD pattern of prepared coal sample.

Energy Dispersive X-ray Fluorescence Analysis (EDXRF)

Twelve elements namely S, Si, K, Mn, Fe, Ti, Ca, Zn, Cu, Se, Zr, C and H were quantified in the resulting powder of Namma coal sample by EDXRF technique. S, Si, K, Mn, Fe, Ti, Ca, Zn, Cu, Se and Zr were present as minor element. Other elements like Carbon and Hydrogen (C, H) 97.922 % were present as major concentration.

Dielectric Constant (G^W INSTEK LCR-821)

The dielectric constant is a measure of the amount of electricity that can be stored in coal and is more useful than electrical conductivity in characterizing coal. Dielectric properties of prepared sample of Namma coal in Myanmar are investigated in the frequency from 1 kHz to 200 kHz with G^W INSTEK LCR-821. The dielectric constant decrease considerably with increasing frequency from 1 kHz to 50 kHz and nearly constant up to 200 kHz. It was found that dielectric constant was higher in the lower frequency region and decreases with increasing frequency. Then it was nearly constant at higher frequency region. Dielectric properties of prepared coal sample measured at room temperature as a function of frequency was shown in Figure 2.

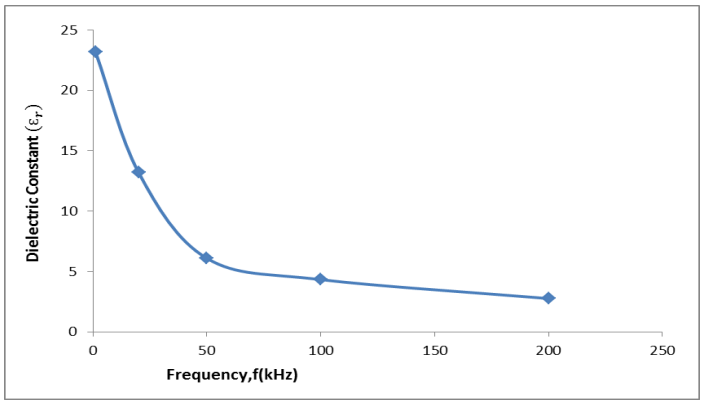

Figure 2 : Dielectric properties of prepared coal sample measured at room temperature as a function of frequency

Magnetic Properties (Permagraph L Apparatus)

The magnetization and demagnetization properties of prepared coal sample was shown in Figure 3. The variation of the coercive force (H_c) and remanence (B_r) have been investigated using B-H loops as a function of applied magnetic field. The room temperature magnetic hysteresis loop measurement demonstrated that the sample was soft magnetic nature. Table 1 shows the value of magnetic parameter of prepared coal sample.

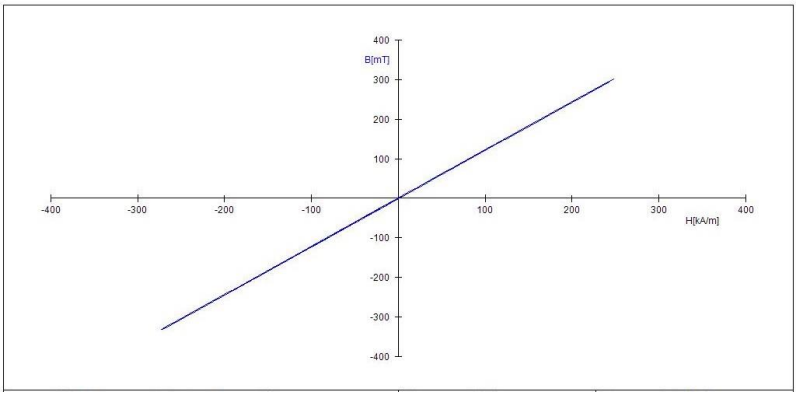

Figure 3 : The Magnetization and demagnetization properties of prepared coal sample

Table 2 : The magnetic parameters of prepared coal sample.

Magnetic parameters	room temperature
Remanence (B_r) (T)	0.00133
Normal coercivity (H_{CB}) (kAm^{-1})	1.05
Intrinsic coercivity (H_{CJ}) (kAm^{-1})	31.8
Maximum energy product $(BH)_{max}$ (kJm^{-3})	0.00018

Conclusion

In the primary study, sample from Namma coal field has been prepared by modified Hummer's method. The prepared coal sample was quantified by EDXRF spectrometer. Carbon and Hydrogen (C,H) were found to possess the highest concentration. The structural characterization of resulting powder of Namma coal has been conducted by X-ray Diffraction (XRD) technique. The intensity and sharpness of the peaks give an indication of the degree of order compared to that of a graphite crystal. The room temperature dielectric constant was measured in the frequency range 1 kHz to 200 kHz by using LCR 821 meter. It was found that the dielectric constant of these samples decrease with increasing frequency. Magnetic hysteresis loops of samples are thin because the samples are determined as soft magnetic material.

Acknowledgement

I would like to express appreciation to Rector Dr Win Naing, Pro-rector Dr Sein Sein Aung and Pro-rector Dr Thet Naing Oo, Monywa University, for their encouragement and kind permission to undertake the present research. I also would like to express my profound thanks to Professor Dr Phoe Kyi, Head of Department of Physics, Monywa University, for his kind permission to carry out this work, their encouragement and help during this work.

References

Rautray, T.R, Behera, B, Badapanda, T, Vijayan, V and Panigrahi, 2009, "Trace element analysis of fly ash samples by EDXRF technique". Valliammai Engineering College, SRM Nagar, Chennai-603 203, Tamil Nadu, India.

Saikia, B.K, Boruah, R. K and Gogoi, P.K, 2007 "FT-IR and XRD analysis of coal from Makum coalfield of Assam", Department of Chemical Sciences, Tezpur University, Napaam, Tezpur 784 028, India. Analytical Chemistry Division, Regional Research Laboratory (CSIR), Jorhat 785 006, India. Department of Chemistry, Dibrugarh University, Dibrugarh 786 004, India.

Lucía Fernández-García, Marta Suárez, José Luis Menéndez, Carlos Pecharromán, Rosa Menéndez and Ricardo Santamaría, 2015, "Dielectric behavior of ceramic–grapheme composites around the percolation threshold", Nanoscale Research Letters, Spain.

Geetika Khurana, Nitu Kumar, Sudheendran Kooriyattil, and Ram S. Katiyar, 2015, "Structural, magnetic, and dielectric properties of graphene oxide/$Zn_xFe_{1-x}Fe_2O_4$ composites", Institute of Functional Nanomaterials and Department of Physics, University of Puerto Rico, Rio Piedras, San Juan, PR 00936-8377, USA.

Buschaw, K. H. and De Bore, F. R., (2004). "Physics of Magnetism and Magnetic Materials".

Crangle, J., (1997). "The Magnetic Properties of Solids" (London: Edward Arnold)

Michael D. Campbell, M. David Campbell, Jeffrey D. King, Henry M. Wise, 2014, "Coal, Just Not for Burning", AIPG Journal, The Professional Geologist, pp. 21-25.