Title	Synthesis and Characterizations of Clay from Kan Khunit Sint Lake (Lake with seven steps), Loikaw, Kayah State
All Authors	Shwe Sin Oo
Publication Type	Local publication
Publisher (Journal name, issue no., page no etc.)	Journal of the Myanmar Academy of Arts and Science (Jour. Myan. Acad. Arts & Sc. 2016 Vol. XIV. No.2)
Abstract	Clays occur in huge quantities, need improvement by stabilization or by replacing them with granular material. Current, nanotechnology based Advanced Ceramics has changed our vision, expectations and abilities to control the material world. The developments in nano-science can also have a great impact on the field of construction materials. Portland cement, one of the largest commodities consumed by mankind, is obviously the product with great. Nano-reinforced composite building materials were developed on the base of quartz raw material. In this preliminary work, the structural analysis of the clay samples from Kan Khunit Sint lake, Demawso Township, Loikaw, Kayah State, in air at the room temperature were investigated by EDXRF (Energy Dispersive X-ray Fluorescence) and XRD (X-ray Diffraction analysis). The tridymite SiO_2 (lower temperature range) formed as nano-SiO_2 (~71 nm) in the clay samples and others materials Si, Fe, Ca, K, Ti, Mn, and Zr were detected. It is also called nanoclay that can be considered as reinforced material to become composite cement. These cement eco-nano composites can provide new insights for the development of new 'environmental-friendly nanomaterials' for building applications such as the construction of sandwich panels, ceilings and roofs.
Keywords	Clay, quartz, structural analysis, EDXRF, XRD, cement, nano-SiO_2
Citation	
Issue Date	2016

Synthesis and Characterizations of Clay from Kan Khunit Sint Lake (Lake with seven steps), Loikaw, Kayah State

[1]Shwe Sin Oo

Abstract

Clays occur in huge quantities, need improvement by stabilization or by replacing them with granular material. Current, nanotechnology based Advanced Ceramics has changed our vision, expectations and abilities to control the material world. The developments in nano-science can also have a great impact on the field of construction materials. Portland cement, one of the largest commodities consumed by mankind, is obviously the product with great. Nano-reinforced composite building materials were developed on the base of quartz raw material. In this preliminary work, the structural analysis of the clay samples from Kan Khunit Sint lake, Demawso Township, Loikaw, Kayah State, in air at the room temperature were investigated by EDXRF (Energy Dispersive X-ray Fluorescence) and XRD (X-ray Diffraction analysis). The tridymite SiO_2 (lower temperature range) formed as nano-SiO_2 (~71 nm) in the clay samples and others materials Si, Fe, Ca, K, Ti, Mn, and Zr were detected. It is also called nanoclay that can be considered as reinforced material to become composite cement. These cement eco-nano composites can provide new insights for the development of new 'environmental-friendly nanomaterials' for building applications such as the construction of sandwich panels, ceilings and roofs.

***Key words*:** Clay, quartz, structural analysis, EDXRF, XRD, cement, nano-SiO_2

Introduction

Myanmar has large amount of lakes, streams and rivers and many of these areas are deposited with soft clay. Kayah state has also many lakes and rivers. For future regional development, the clay samples were collected from Kan Khunit Sint lake, Demawso Township, Loikaw, Kayah State (Fig.1), situated in southeast Myanmar, it is bounded on the north by Shan State, on the east by Thailand's Mae Hong Son Province, and on the south and west by Kayan State as shown in (Fig. 2). The area is 11,670 km^2 (4,510 sq mi). It locates about 2950ft above the sea-level and hilly region. Demawso township, is located in valley a highland region. Kayah State has so many natural resources such as minerals, forests, water and soil for regional development. Therefore, the hemps were also collected from Lawpita forest, Kayah state (Fig.3) to fabricate as a hemp fabric nanoclay composite cement.

[1]Demonstrator, Department of Physics, East Yangon University

Clay are soft , low strength and high compressibility characteristics . These are the major reasons of the design analysis could be taken for any structure .So, the characterizations of the clay was investigated and also to study the advanced ceramics of nano-clay with physical densities, porosity and absorbing water properties of reinforced composite materials. Better understanding and engineering of complex structure of cement based materials at nano-level will definitely result in a new generation of concrete, stronger and more durable, with desired stress-strain behavior and, possibly, with the whole range of newly introduced "smart" properties[1]. Many researchers investigated to modify the traditional ceramic materials to make them more user-friendly, and into designing novel reinforced composites of naturally occurring materials.

Going beyond the hellenic word *keramos* ("fired soil"), on the one hand, *ceramics* is defined as a name for products made out of non-metallic inorganic substances, and on the other hand, *ceramics* is defined as the art and science of making materials and products of non-metallic inorganic substances. Silicates clay products, cement and silicate glasses etc., are traditional ceramics. However, advanced ceramics meets the highest demands of present technologies . For instance, many advanced ceramic materials are extremely resistant against abrasion, heat and also have further constraint properties such as temperature and pressure, ceramic materials can be insulators, conductors, and semi-conductors. The advanced research of the last few years has shown that it is possible to produce high performance natural fiber composite based clay matrix, cement and lime or polymer matrix capable of meeting any engineering demand in terms of strength and energy absorption capability [9].

Recently, nanoparticles are used in polymer, ceramic and construction materials, particularly producing nanocomposites which have superior physical and mechanical properties [2]. In the construction industry, several types of nanoparticles have been incorporated into concretes such as nano-SiO_2, nano-Al_2O_3, nano-Fe_2O_3, nano-ZnO_2, nano-$CaCO_3$, nano-TiO_2, carbon nanotubes and nano-metakaolin in order to improve the durability and mechanical properties of concrete [3–6]. Natural and cellulose fibres are used in polymer and cement matrices to improve their tensile/flexural strength and fracture resistance properties [10,11]. They are cheaper, biodegradable and lighter than synthetic fibres. Some examples of natural fibres are: cotton, sisal, flax, hemp, bamboo, coir, wheat straws and others [12,14] . In contrast, the use of natural fibre sheets and fabrics is more prevalent in polymer matrix when compared to cement-based matrix. For example, using cellulose sheets in epoxy or viny-ester matrix have improved the fracture toughness significantly [8,15,16]. In this work, structure

analysis and material compositions of clay was investigated by EDXRF and powder X-ray diffraction(XRD) methods. And then, hemp fabric nanocomposite clay was made and also studied by XRD.

Fig. 1 Kan Khunit Sint Lake, Demawso Township, Loikaw, Kayah State

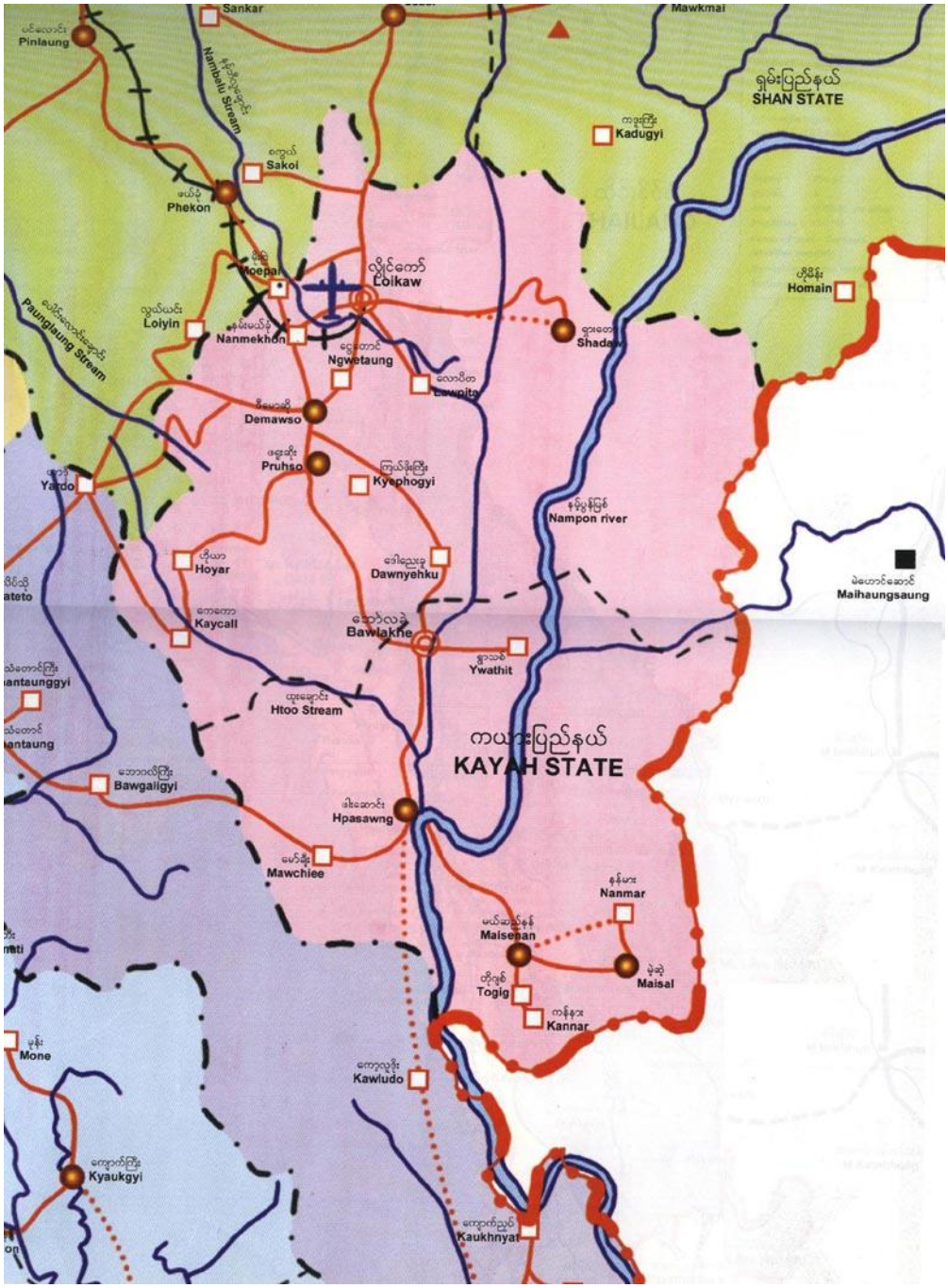


Fig.2 Map of Kayah State

(a) (b)

Fig. 3 (a) and (b) The hemps form Lawpita forest, Kayah State

Experimental Method

This section describes with the two parts: the details of collection of the clay samples, preparation and the experimental procedures for characterization of sample and the preparation of natural hemp fabric reinforced nanoclay composites cement for characterization.

(a) Sample Collection and Preparation

Firstly, the soft clay samples were collected under 2 feet depth of water from the Kan Khunit Sint lake, Demawso Township. It is 12 miles far from the Loikaw City, Kayah State. That lake is very pleasant and one of the historical places of Kayah State (Fig. 4).

Secondly, it was made the pellets to dry under the sun at 32°C for 5 hrs followed by three days (Fig. 5 and Fig. 6). Thirdly, after well dried, the sample was ground by the blander. The powdered clay was then filtered with filter cloth to get the homogeneous powder clay samples.

Fig.4 Kan khunit Sint lake, Demawso township, loikaw, Kayah State

Finally, structure analysis of clay powder samples were performed by RIGAKU, MULTIFLEX X-ray diffractometer using Ni-filter with CuK_{α} radiation, using a wavelength λ = 1.54056 Å located at Universities' Research Centre (URC), University of Yangon. The angle range 2θ was observed 10°-70°. The relative abundances of the phase formed were analyzed using JCPDS (Joint Committee on Powder Diffraction Standards). Lattice parameters of sample has been examined.

Fig. 5 The clay sample from Kan Khunit Sint lake, Demawso township, Loikaw, Kayah State

(a)

(b)

Fig. 6 (a) and (b) The pellets of dried clay

(b)Energy Dispersive X-ray Fluorescence (EDXRF) Analysis

The dried clay powders was investigated by EDXRF analysis to analyze the composition of materials and to approach which properties of the clay may be applied.

(c) Sample preparation of hemp fabric reinforced nanocomposites

Firstly, the hemp was layered as a thickness of 0.74 mm (Fig. 7) and then the hemp fabrics were washed with water and dried for 1 hr at room temperature before beginning the casting , in order to reduce the effect of water absorption by hemp fabric[8]. Secondly, the hemp fabric were made as a hemp layer with the thickness of each hemp of 0.74 mm(Table 1).

On the other hand, the cement and nanoclay powder were first dry mixed as a ratio of clay 1% and 2% homogeneously and then the cement nanocomposite paste(matrix) was prepared by adding water. The hemp layers were before laied downed into the mould, each layer was initially socked into the nanocomposite matrix for 3 min and it was pressed and rolled under weight 4kg for about 3 min to reduce the air bubbles and voids inside the specimen(Fig. 8). It is very critical. Thirdly, the 5 layers of hemp fabric were used in hemp fabric reinforced nanocomposites, in which their positions were placed above and below the nanocomposite sample over the depth of the specimen. The fabrication of hemp fabric reinforced nanocomposite specimen was made by the layer. First, the thick layer of cement matrix about 10 mm depth was poured into the mould, then the pre-socked hemp fabric sheet about 0.7 mm was laid on the top of it. After that, another thin layer of matrix about 2 mm depth was poured into the mould followed by the other pre-socked hemp fabric and then the final thick layer of matrix about 10mm depth(Fig. 9). After that, the specimens were dried under the sun followed by 2 days. And then, the specimen was removed from the mould. Finally, the rectangular shape of 85 x 45 x 32 mm^3 hemp fabric reinforced nanocomposites specimens were obtained.

Fig. 7 Hemp fabric layer

Fig.8 The pre-socked hemp fabric

Fig.9 Hemp fabric reinforced nanoclay cement

Table 1 Structure of hemp fabric

hemp thickness(mm)	0.74
Hemp geometry	Woven(plain wave)
Number of hemps in a bundle	22

(d) X-ray Diffraction (XRD) Analysis

Material characterization is an essential to understand the nature of things. It is required that technique selection must be matched to form of the sample and physical basis of the analytical probe.

X-ray diffraction (XRD) is a powerful technique. It is the most widely used for the identification of unknown crystalline materials (e.g., minerals, inorganic compounds). Other applications are the characterization of crystalline material, identification of fine-grained materials such as clays and mixed layer clays that are difficult to determine optically, determination of unit cell dimensions and measurement of sample purity.

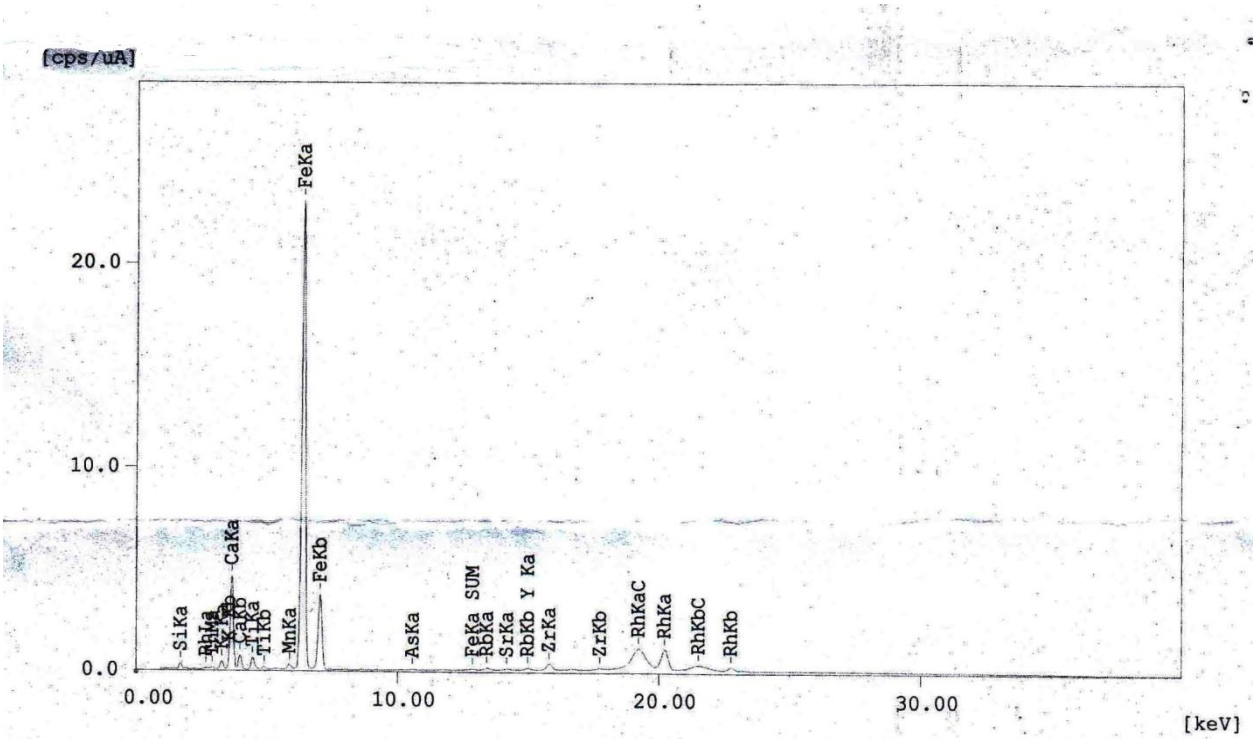
The study of solids is a rich scientific area, which depends on a great variety of experimental probes. Techniques using electromagnetic radiation are among the most fruitful of these. The very short wavelengths of X-rays are instrumental, even essential, in examining the atomic lattices that define crystalline solids [7].

Results and Discussion

Fig. 10 shows the existence of an outer surface quantitative chemistry elements Si, Fe, Ca, K, Ti, Mn, and Zr of clay samples by EDXRF and the chats show the highest composition element Si(42%) clearly(Fig.11). According to first preliminary test for clay samples from Loikaw, Kayah state, XRD results show the highest of element composition of Si (42wt%) when it supersaturated state is reached as in during air-oxidation, the Si element out to form SiO_2 (Tridymite) at about room temperature (Fig. 12). All of the XRD data of diffraction angle (2θ), atomic spacing (d), intensity (I) and miller indices (hkl) are listed in (Table 2). The obtained XRD data are mostly agreed with standard data of JCPDS. According to XRD pattern, the clay sample belongs to trigonal structure at room temperature. The diffraction line of (011) plane at 26.723° is found to be strongest one.

The crystallite size of the sample was calculated from the XRD peak broadening of the highest intensity using the Scherrer's formula: $t = \frac{0.9\lambda}{B\cos\theta}$ where t is the crystallitesize (nm), λ

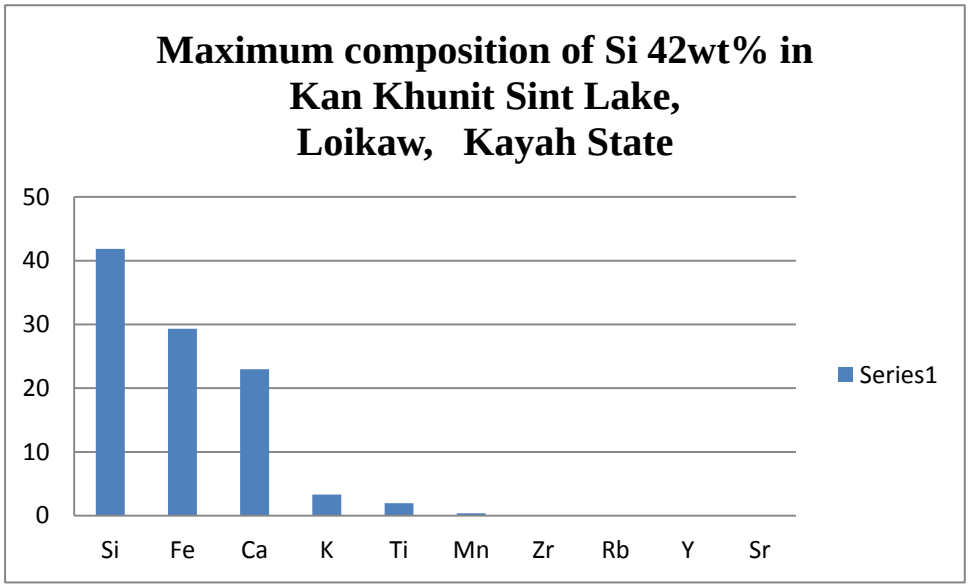
is the wavelength of incident X-ray (nm), θ is the diffraction angle of the peak under consideration at FWHM (°) and B is the observed FWHM (radians). The crystallite size of the sample is obtained as 71 nm using the line at 26.723° or (011).



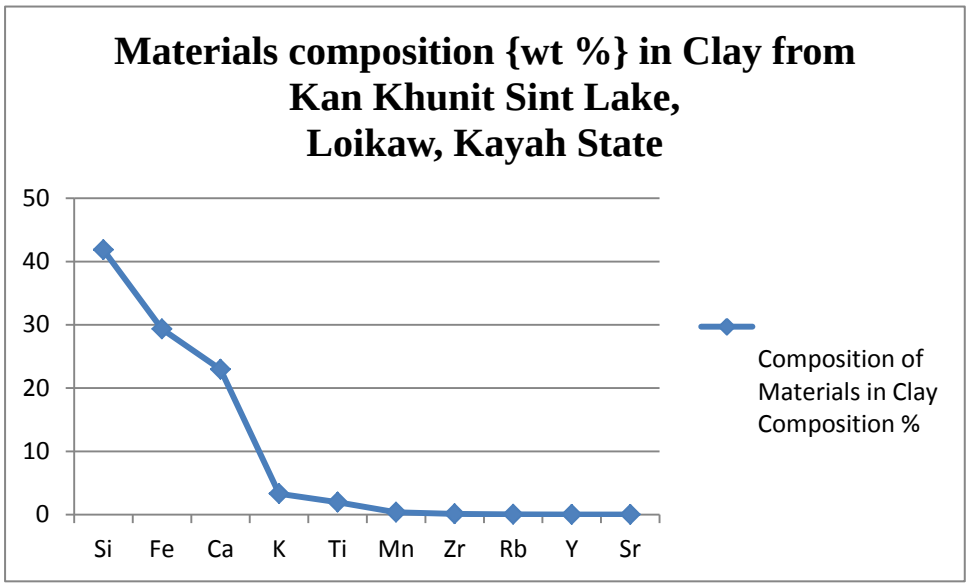
Quantitative Result

Analyte	Result	[3-sigma]	Proc.-Calc.	Line	Int.(cps/uA)
Si	41.839 %	[1.279]	Quan-FP	SiKa	1.7469
Fe	29.324 %	[0.103]	Quan-FP	FeKa	192.9270
Ca	22.960 %	[0.193]	Quan-FP	CaKa	32.5960
K	3.307 %	[0.082]	Quan-FP	K Ka	2.8450
Ti	1.971 %	[0.041]	Quan-FP	TiKa	4.4043
Mn	0.382 %	[0.017]	Quan-FP	MnKa	1.9650
Zr	0.114 %	[0.004]	Quan-FP	ZrKa	3.6833
Rb	0.051 %	[0.004]	Quan-FP	RbKa	1.1910
Y	0.028 %	[0.003]	Quan-FP	Y Ka	0.8243
Sr	0.023 %	[0.003]	Quan-FP	SrKa	0.6112

Fig. 10 The EDXRF pattern of the Clay sample from the Kan Khunit Sint lake, Loikaw, Kayah State



(a)



(b)

Fig. 11 (a) and (b) The Chat of the Composition of the Clay sample from the Kan Khunit Sint lake, Loikaw, Kayah State

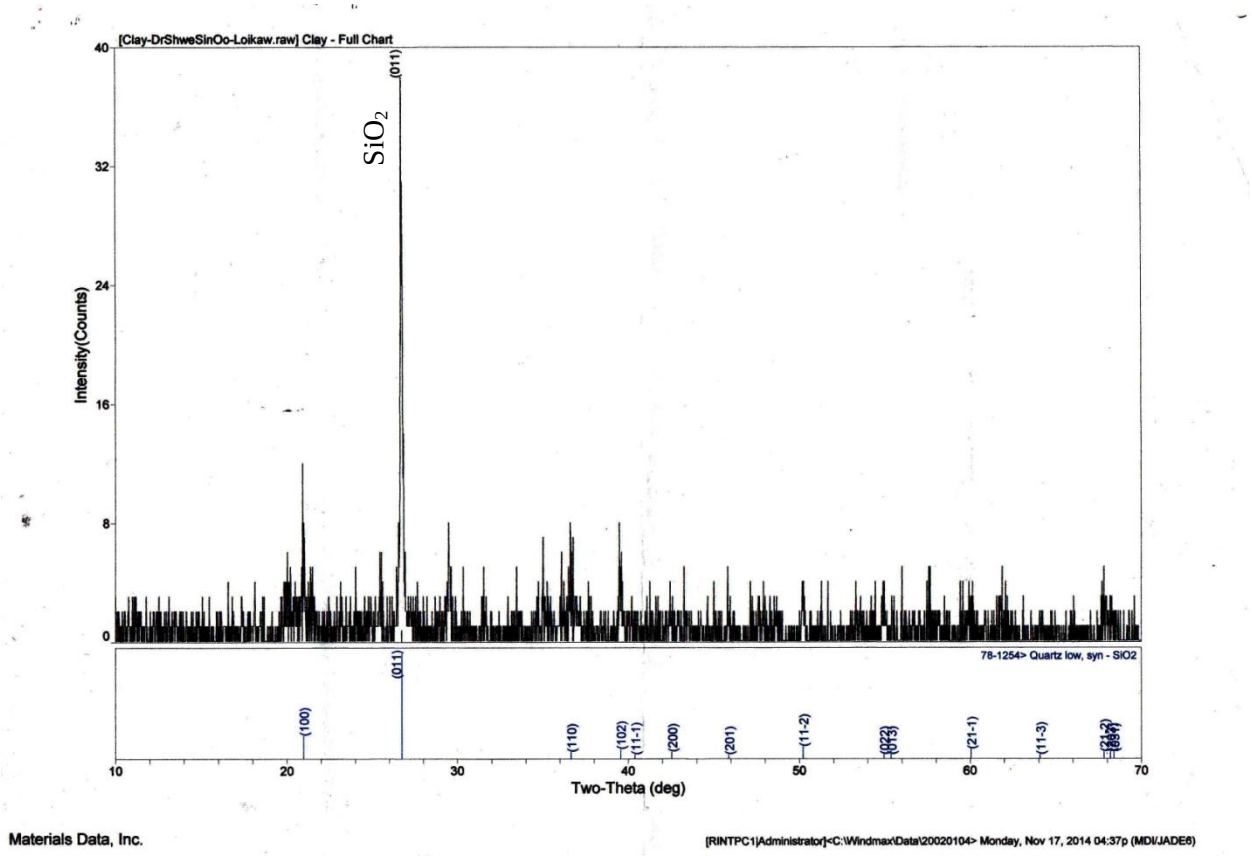


Fig 12 XRD pattern of the Clay from Kan Khunit Sint lake, Loikaw, Kayah State

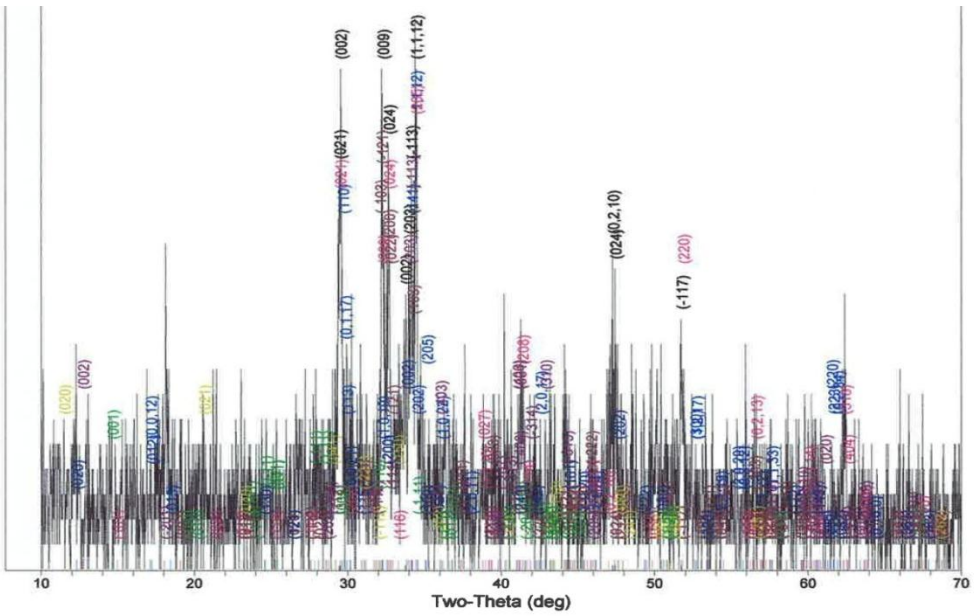
Table 2 XRD data of the Clay from Kan Khunit Sint lake, Loikaw, Kayah State

Line No	Phase formed	2θ (°)	(hkl)	*d* (Å)	I (%)	Nanosize
1	SiO_2	26.723	(011)	3.3332	100	71

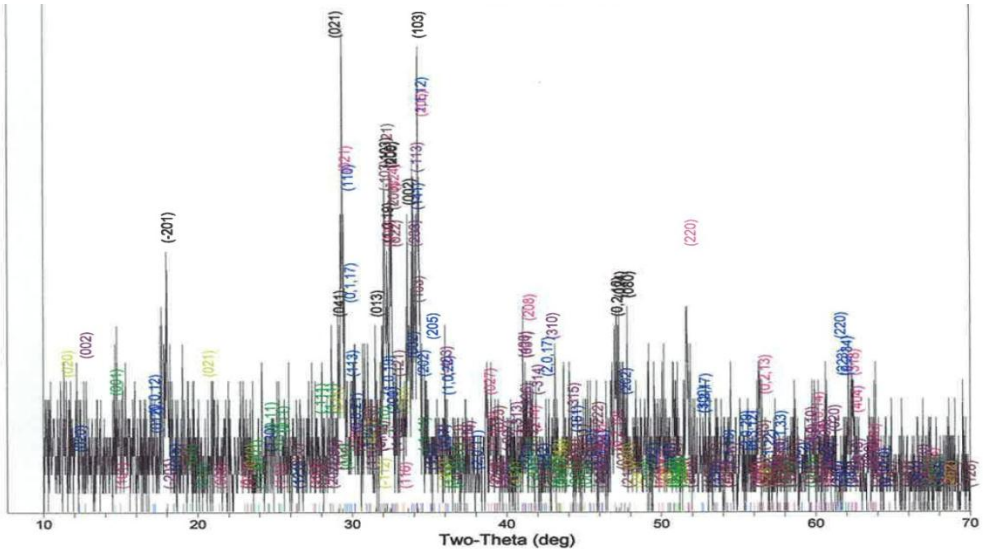
Fig 13 shows the XRD pattern of cement paste and nanoclay (1% and 4%) composites. The four important phases are noticed in this study. They are calcium iron oxide, calcium silicate oxide, larnite and calcium aluminum iron oxide. In the clay 4% of XRD pattern , larnite has well -defined crystallize structure, it has four major peaks that corresponds to 2θ angle of 31.54°, 32.11°,34.28° and 47.28°.

The XRD pattern of cement paste and nanocomposites hemp fabric containing 1-2% nanoclay are shown in Fig 14. Four important phases are noticed in these two pattern: calcium silicate oxide, larnite, calcium iron oxide and calcium aluminum iron oxide. Among them, the composition of larnite and calcium silicate oxide has the well-defined crystallized structure and they have 3 and 2 major peaks that corresponds to 2θ angle of 32.2°,

32.61°,47.22° , 29.41° and 32.46°, and also the crystal plane of Miller indices (hkl) of (-1 2 1),(2 0 0),(0 2 4),(0 2 1) and (0 0 9) respectively. Some overlaps of peaks are found and they have low intensities. In this XRD patterns, larnite can be seen vividly.

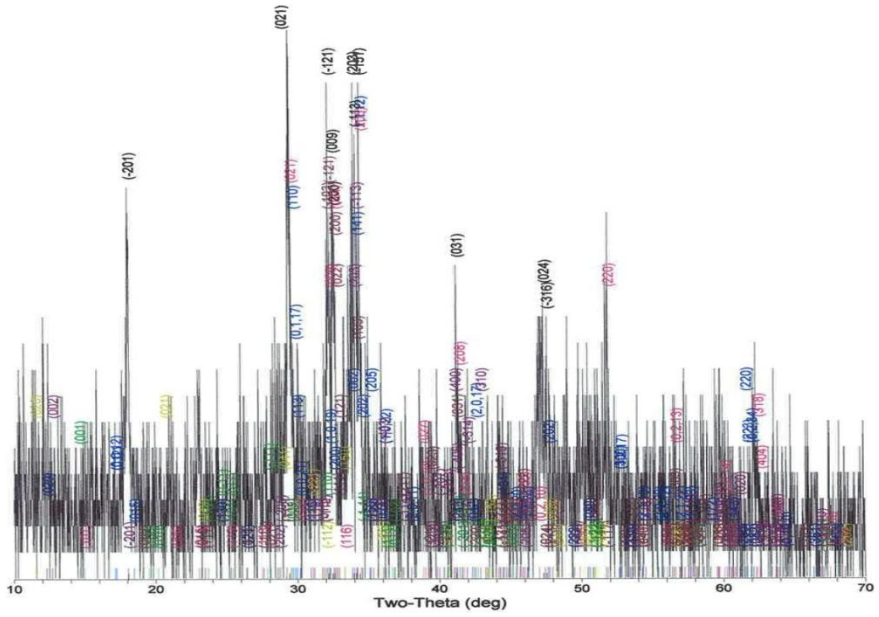


(a)

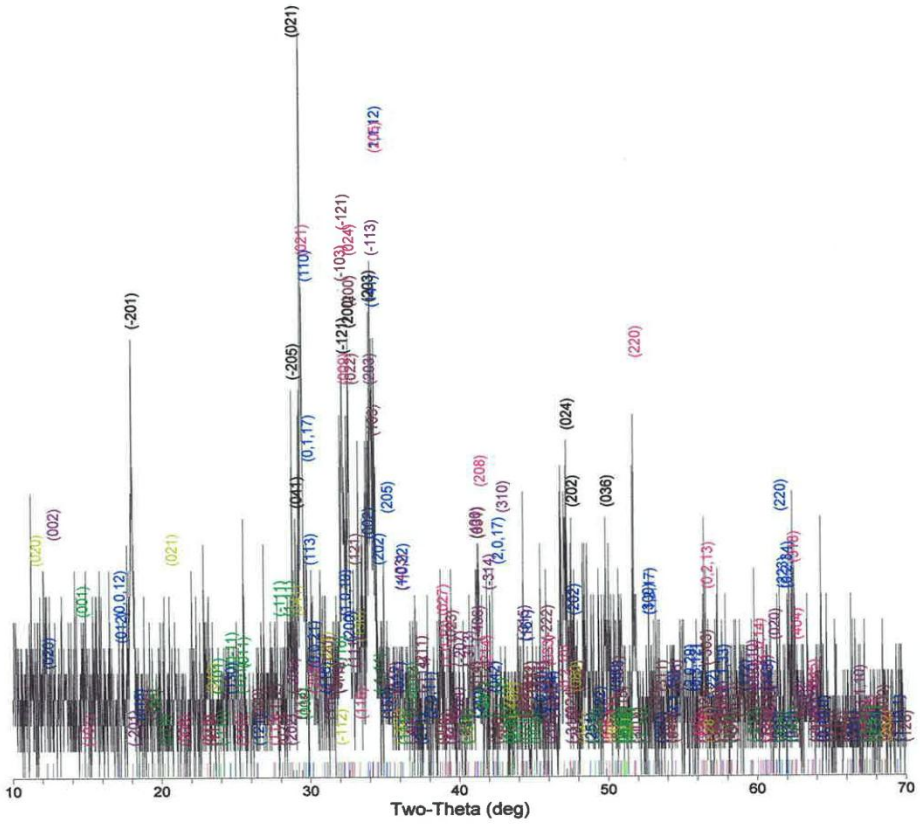


(b)

Fig. 13 XRD patterns of nanoclay cement paste (a) clay (4%), (b) clay (1%)



(a)



(b)

Fig. 14 XRD patterns of hemp fabric nanocomposites cement pate (a) clay (1%) , (b) clay (2%)

Conclusion

Clay powder samples was investigated by EDXRF and XRD analysis to approach the advanced ceramics of nano clay reinforced composite cement as a relatively new eco-friendly binder material in improving the strength characteristics of clay. According to experimental results, clay can be considered as nano-clay (~71nm) potential advanced ceramic materials. Some potential Advanced Ceramics are Al_2O_3, SiO_2, TiC, SiC, TiO_2, Al_2TiO_5, Ti_3SiC_2 and Ti_3AlC_2. Potential applications include structural laminate, sandwich panels, ceilings, roofing sheets, on-ground floors and concrete tiles. It can also be considered as a reinforced composite cement based materials at the nanolevel will apparently results in a new generation of concrete, stronger and more durable, with desired stress-strain behavior and, possibly, with the range of newly introduced properties, such as electrical conductivity, temperature-,moisture-, stress- sensing abilities. At the same time, this new concrete should be sustainable, cost and energy effective – in essence exhibiting the qualities modern society demands. The above statements are all really essential need for the regional development for the Higher Education and Science and Technology for the Kayah State.

Acknowledgements

I would like to thank Dr. Aung Win Kyi, Rector, Loikaw University, Dr Maung Maung and Dr Soe Myint Thein, Pro- Rectors, Loikaw University and Professor Dr. Khin Yu Mon, Head of department of Physics, Loikaw University for their kind permission to carry out this work. I am deeply indebted to my advisor Dr. Zeya Oo, Ph.D (Advanced Ceramics, Curtin), MlnstP (UK), Senior Lecturer, Curtin University, Malaysia, for his valuable supervision and guidance for this work. I am also extremely grateful to my advisor Dr Thein Thein Kyaw, Ph.D(Engineering Chemistry) for her valuable guidance to start up this work. I am also thankful to my students from Loikaw University for their deeply help of sample collection.

References

1. Konstantin Sobolev, Ismael Flores, Roman Hermosillo, Leticia M. Torres-Martínez "Nanotechnology of Concrete: Recent Developments and Future Perspectives" November 7, 2006, Denver, USA

2. Alhuthali A, Low I. M, Dong C. Characterization of the water absorption, mechanical and thermal properties of recycled cellulose fibre reinforced vinylester eco-nanocomposites. Composites Part B 2012;43(7):2772–81.

3. Nazari A, Riahi S. The effects of Zinc Oxide nanoparticles on flexural strength of self-compacting concrete. Composites Part B 2011;42(2):167–75.

4. Morsy MS, Alsayed SH, Aqel M. Hybrid effect of carbon nanotube and nanoclay on physico-mechanical properties of cement mortar. Constr Build Mater 2011;25(1):145–9.

5. Givi A, Rashid S, Aziz F, Salleh M. Investigations on the development of the permeability properties of binary blended concrete with nano-SiO2 particles. J Compos Mater 2011;45(19):1931–8.

6. Qing Y, Zenan Z, Deyu K, Rongshen C. Influence of nano-SiO2 addition on properties of hardened cement paste as compared with silica fume. Constr Build Mater 2007;21(3):539–45.

7. Blasse, G. (1964) Crystal chemistry and some magnetic properties of mixed metal oxides with spinel structures. Phillips ResearchR eportsS upplement,3 , l-139.

8. Low JM, Hakamy A, Shaikh FUA, "Characteristics of hemp fabric reinforced nanoclay–cement Nanocomposites" Cement & Concrete Composites 50(2014)27-35.

9. Marwen Bouasker , Naima Belayachi, Dashnor Hoxha and Muzahim Al-Mukhtar **,** **"**Physical Characterization of Natural Straw Fibers as Aggregates for Construction Materials Applications " *Materials* 2014, *7*, 3034-3048; doi:10.3390/ma7043034.

10. Silva F, Movasher B. Cracking mechanisms in durable sisal fiber reinforcedcement composites. Cem Concr Compos 2009;31(10):721-30.

11. Islam S, Hussain R, Morshed M. Fiber-reinforced concrete incorporating locally available natural fibers in normal-and high-strength concrete and a performance analysis with steel fiber-reinforced composite concrete. J Compos Mater 2012;46(1):111–22.
12. Sedan D, Pagnoux C, Smith A, Chotard T. Mechanical properties of hemp fibre reinforced cement: influence of the fibre/matrix interaction. J Eur Ceram Soc 2008;28(1):183–92.
13. Ali M, Liu A, Sou H, Chouw N. Mechanical and dynamic properties of coconut fibre reinforced concrete. Constr Build Mater 2012;30:814–25.
14. Elsaid A, Dawood M, Seracino R, Bobko C. Mechanical properties of kenaf fiber reinforced concrete. Constr Build Mater 2011;25(4):1991–2001.
15. Alhuthali A, Low IM, Dong C. Characterization of the water absorption, mechanical and thermal properties of recycled cellulose fibre reinforced vinylester eco-nanocomposites. Composites Part B 2012;43(7):2772–81.
16. Alamri H, Low IM, Alothman Z. Mechanical, thermal and microstructural characteristics of cellulose fibre reinforced epoxy/organoclay nanocomposites. Composites Part B 2012;43(7):2762–71.