X-ray Mass attenuation coefficients of Nb$_2$O$_5$ over the energy range 18.9132-19.6882

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Abstract. We use the Extended X-ray absorption fine structure (EXAFS) to measure the mass attenuation coefficient of Nb$_2$O$_5$ Niobium compound in the X-ray energy range 18.9132 - 19.6882 keV. The results represent the most extensive experimental data set for Nb$_2$O$_5$ and include absolute mass attenuation coefficients in the region of extended x-ray absorption fine structure. Comparison of the results with tabulations of calculated photo electric absorption coefficients indicate the differences between the calculated and observed values with the theoretical predictions.

Keywords: Mass Attenuation Coefficient; Synchrotron Radiation; EXAFS.

1. Introduction

With wide spread usage of radiation and radioisotopes in industry, medication and essential sciences, the issue of radiation assurance has become significant perspective while taking care of radiation sources and radiation producing types of gear. Determination of materials for radiation protecting and assurance needs precise appraisal of association parameters. The collaboration study in expanding uses of low vitality photons is significant in fundamental perspectives on the two looks into that is nuclear material science and in applied physical science [1]. The degree of retention relies upon the photon energy. The estimations of ingestion esteems have been accounted for on the different sorts of materials, for example, components, mixes, amalgams, substantial metal oxide borate glasses, soils and building materials, and so on. [2-10].

X-ray attenuation measurements near the absorption edge using radioactive source are very limited and in many cases it was the extrapolation method which was used to measure attenuation value exactly near the edge-jump [11, 12]. To beat this extrapolation technique one have to go for a continuous energy source (SR) is one such source which can be tuned near to the edge-jump, with the goal that one can go for precise estimations near and around the edge-jump. In this way, it is beneficial to embrace attenuation estimations to cover a portion of the existing gaps around the absorption edge and this coefficient is an essential parameter for some examinations. [13].

A Large number of measurements have been reported over the years to determine attenuation coefficients using synchrotron radiation [14-18]. This encouraged taking up a systematic work in the present study where experimental mass attenuation coefficient is evaluated for Niobium compound using synchrotron radiation which remains one of the most useful material. The measured values are compared with X-COM which was developed by [19] and FFAST [20] theoretical values.
2. Material and Methods

2.1. Sample Preparation
The measurement of mass attenuation coefficient data of Niobium compound Nb\textsubscript{2}O\textsubscript{5} which was obtained from Alfa Aesar, Quoted purity of 99.9% and prepare pallets with a Nb\textsubscript{2}O\textsubscript{5} powder.

2.2. Method
A method for the determination of the mass attenuation coefficient (\(\mu/\rho\)) using synchrotron radiation as shown in Figure 1. Which operates in the energy range of 4-25 keV using Si (111) double crystal monochromator (DCM) have been discussed in earlier literature [21]. The element used for the measurement of mass attenuation coefficient data of Niobium compound Nb2O5 which was obtained from Good Fellow, England, quoted purity of 99.9%. Measured values were compared with theoretical values using XCOM and FFAST as shown in Figure 2. The X-ray energy absorption fine structure (XAFS) spectra of the sample were recorded in the energy range from 18.9132 to 19.6882 keV, and the mass attenuation coefficient of the sample is determined as a function of energy.

![Figure 1. Schematic layout of BL-09, RRCAT, Indore, India.](image)

Figure 1. Scanning EXAFS BL-09, RRACT, Indore

3. Results and Discussion
The outcomes incorporate the estimations of the mass attenuation coefficients of Nb2O5 compound utilizing synchrotron radiation source from energy 18.9132 to 19.6882 keV. The deliberate qualities are contrasted and hypothetical qualities anticipated utilizing XCOM and FFAST techniques. The estimations were done at a very fine energy steps of 0.0003 keV. From the diagram, in Figure 2, it is seen that near the pre-edge region, i.e., from 18.9132 to 18.958 keV the deliberate qualities are not exactly the hypothetical qualities anticipated utilizing XCOM and the deviation is 46-50%. Fascinating point is to be noticed that there is no oscillatory nature found in the pre-edge region, which had covered an energy range of 0.045 keV in the present work. Precisely close to the hypothetical k-edge jump i.e., 18.990 keV, the deviation is 58%. One can see from the Figure 2 that the experimental k-edge jump energy is 19.005 keV, where the deviation got is diminished by 2.7%.

The oscillatory nature is seen from 18.984 to 19.124 keV, which had secured a energy range of 0.14 keV over the observed k-edge jump with attenuation coefficient shifting from 57-23%. As we are moving endlessly from the observed k-edge jump the oscillatory nature is decreased to smooth line which secured a energy range from 19.124 to 19.688 keV. The present work had secured a complete vitality of under 1 keV where a fine energy steps of 0.0003 keV is utilized at regular intervals to carry...
the attenuation estimations. The oscillatory nature which is seen near to the k-edge jump is because of interference phenomenon resulting in positive and negative deviation of \( \mu/\rho \) values. Peaks in the XAFS spectrum occur due to interference phenomenon of atomic photo electron wave and scattered photo electron wave from neighboring atoms.

The deliberate qualities are likewise contrasted and FFAST hypothetical qualities and the perception don’t discover a lot of contrast when contrasted and XCOM hypothetical readings. The % disparity versus Energy chart of present work with XCOM and FFAST is appeared in Figure.3. The outcomes of the method of fabrication of the of the oil palm trunk particleboards didn’t essentially impacted the mass attenuation.

**Figure.2.** XAFS spectra of Nb\(_2\)O\(_5\) as a function of mass attenuation coefficient (cm\(^2\)/g) Vs energy

**Figure.3.** Comparison between present measurements and theoretical prediction for Nb\(_2\)O\(_5\)
4. Conclusion
The µ/ρ estimations of Niobium compounds was done with three methods of accessible discrete energies in the energy range 15.744-28.564 keV which is a more extensive territory and there a portion of the disparities were seen [22]. To resolve those inconsistencies an examination with a persistent source SR made in the present work which had conveyed with not clear 0.001 keV range with fine energy steps of 0.0003keV precisely near and around the k-edge jump however the deliberate µ/ρ values are deviating from theoretical values to a large extent. Consequently there is need of further trial estimations to beat the deviations.

Acknowledgements
One of the authors (GM) is thankful to the RRCAT, Beam line -9, Indore, India for providing Synchrotron Radiation source facility to carry out the study.

5. References
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