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X-ray Absorption Near Edge (XANES) Studies of Cu-Ni Ferrites

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Abstract – Synthesis of Copper complexes ($Ni_{1-x}Cu_xFe_2O_4$) by the solid root method. XANES spectra have been recorded at the K-edge of Cu using the dispersive beam line at 2.5GeV Indus-2 synchrotron radiation source RRCAT(Raja Ramanna Centre for Advance Technology), Indore, India. All the samples have been studied in powder form. From the $Ni_{(1-x)}Cu_{(x)}Fe_2O_4$ experimental measurements, the energy of the K-absorption edge(E_k),chemical shift(ΔE_k), shift of the principal absorption maxima(E_A),edge widths(E_w) percentage Covalency, and effective nuclear charge (ENC) in these complexes have been estimated.

Keywords- XANES, Athena, Hephaestus.

I . INTRODUCTION

Ferrites are usually nonconductive ferromagnetic compounds derived from oxides such as hematite (Fe_2O_3) or magnetite (Fe_2O_4) as well as oxide of the other metals[1].Cu-Ni Ferrites have gained technological important due to their high electrical resistivity ,low eddy current and low dielectric loss These material are extensively used in microwave device ,computer memory chips, magnetic recording media ,transformer cores, rod antennas etc.[2-5].XANES is strongly sensitive to formed oxidation state and coordination chemistry of the absorbing atom [6].

II. EXPERIMENTAL

Particles of the $Ni_{1-x}Cu_xFe_2O_4$ with x (gm) varying from x=0.05 to 0.25 were prepared by solid root method at room temperature.After weighing grind 8 to 9 hours the sample and powders were sintered at 2-2:30 hours at 550^0c [7]. The X-ray absorption spectra have been recorded using synchrotron radiation source .The X- ray spectroscopy setup is available at Raja Ramanna Centre for Advanced Technology (RRCAT) and is called beam line.

III. RESULTS AND DISCUSSION

The shift of the K-absorption edge of doping copper in the sample with respect to iron that of metal have been determine according to the chemical shift ΔEk. In the present studies K-absorption edge of cu was found to shift to the higher energy state, means chemical shift is positive .The chemical shift values obtained from absorption of ferrites samples are 5.4,6.4,7.4,8.2, 9.8 which suggest that Cu having +2 oxidation state in these types of ferrites. The chemical shift in the X –ray absorption spectra is defined as the energy shift of the absorption edge of metal in a complex to the position in the metallic state [8]. The chemical shift is given by- ΔE= Ek (Complex) –Ek (Metal) ,where E (Complex) = the energy position of the edge of a compound, and E (Metal) = the energy position of the edge of metal[9].

IV. CONCLUSION

In Cu-Ni ferrites, the Chemical shift values obtained from XANES spectra suggest that Cu is present in +2 oxidation state in these types of ferrites[10]. The values of XANES data of k- absorption edge reported in table -1 and XANES graph of copper doped (Ni1-xCuxFe2O4) complexes shown in figure-1.The value of Ek, EA, Shift of principal absorption maxima, Edge Width, and ENC also shown in table 1.

V. REFERENCES

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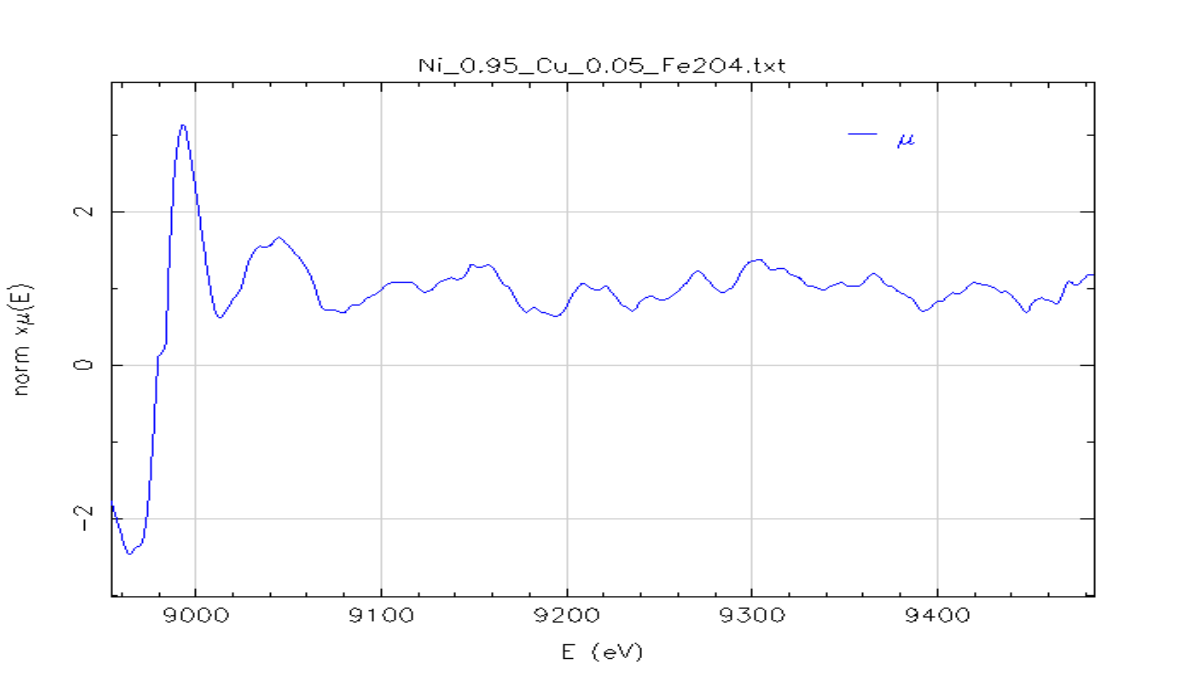
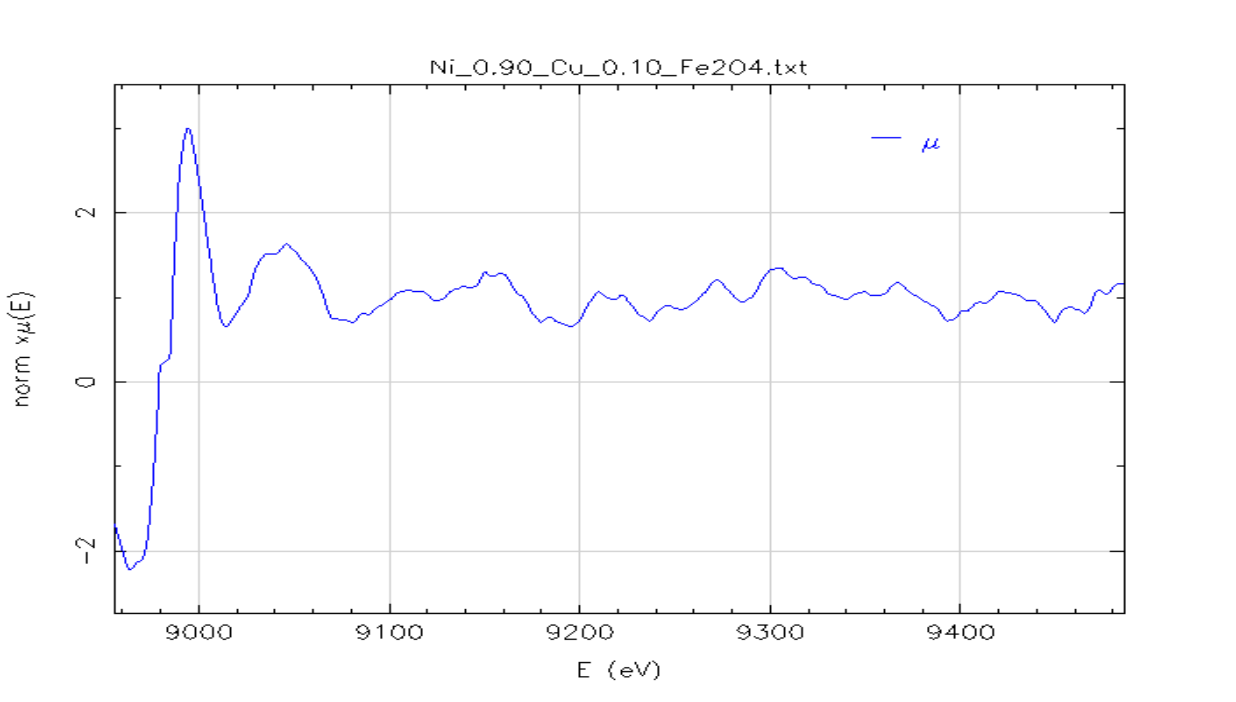
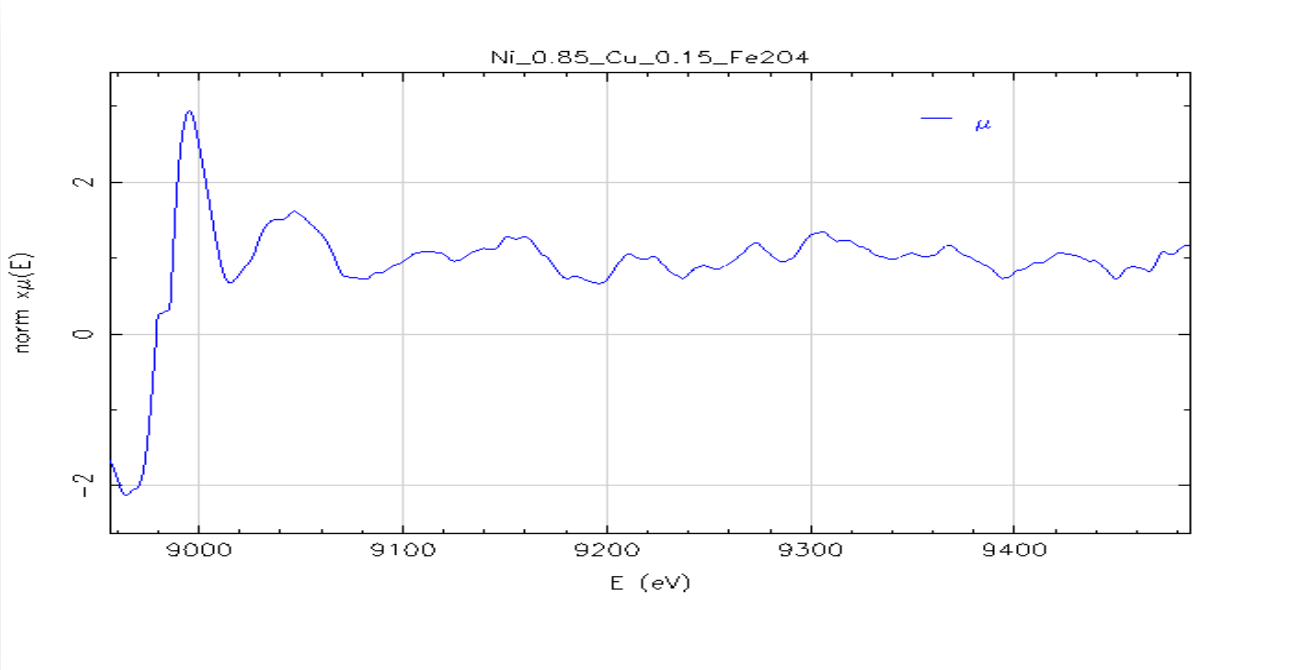
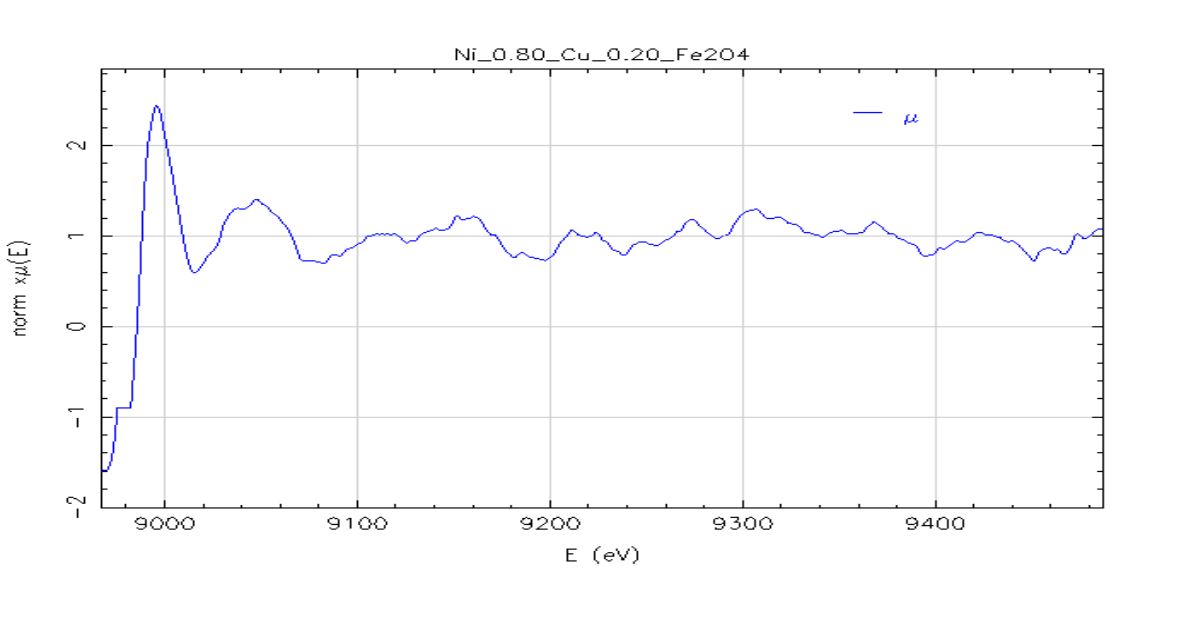
Table-1 XANES data for the K- absorption near edge of Copper complexes

Complexes	E_K-Edge (eV)	E_A (eV)	Chemical Shift (eV)	Shift of principal absorption maxima(eV)	Edge Width (eV)	ENC Electron/ Atom	Percentage Covalancy
$Ni_{0.95}Cu_{0.05}Fe_2O_4$	8984.4	8991.3	5.4	12.3	6.9	0.37	23.79
$Ni_{0.90}Cu_{0.10}Fe_2O_4$	8985.4	8992.7	6.4	13.7	7.3	0.44	25.17
$Ni_{0.85}Cu_{0.15}Fe_2O_4$	8986.4	8993.3	7.4	14.3	6.9	0.51	23.79
$Ni_{0.80}Cu_{0.20}Fe_2O_4$	8987.2	8994.6	8.2	15.6	7.4	0.56	25.51
$Ni_{0.75}Cu_{0.25}Fe_2O_4$	8988.8	8995.7	9.8	16.7	6.9	0.67	23.79









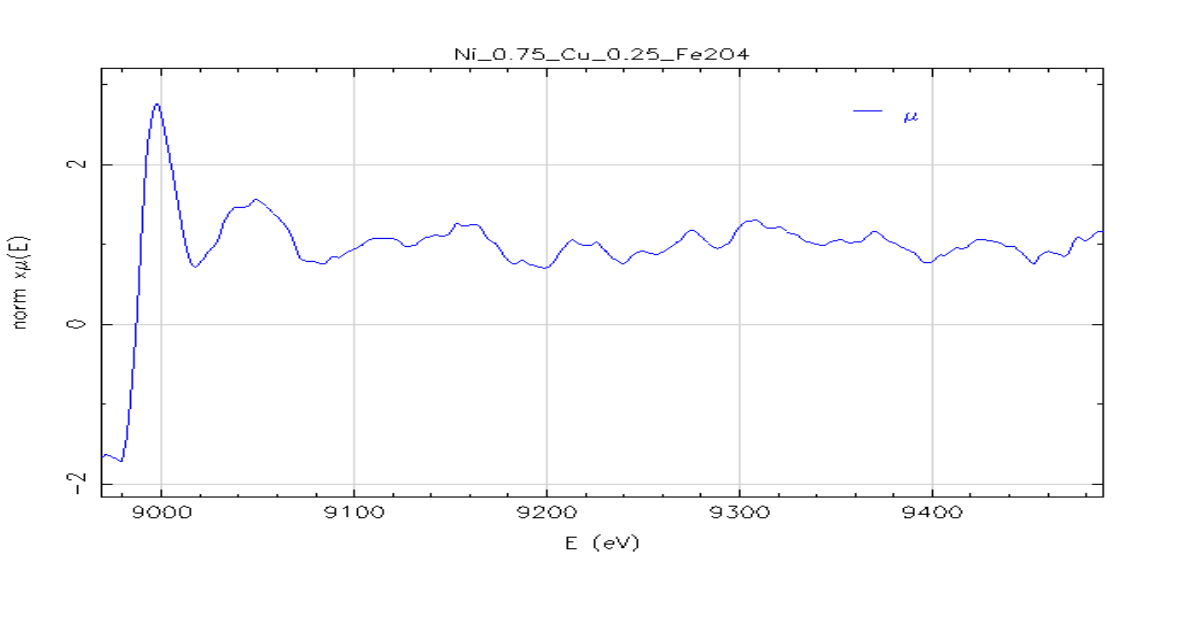


Fig. 1 XANES graphs of copper doped ($Ni_{1-x}Cu_xFe_2O_4$) complexes.

