XANES Studies of RE$_2$TGe$_3$ (RE = Eu, Yb; T = Cu, Ag, Au) and Related Compounds

S. Sarkar and S. C. Peter*

New Chemistry Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur, Bangalore, 560064, India,
Email: sebastiancp@jncasr.ac.in

X-ray absorption near edge spectroscopy (XANES) experiments were performed at PETRA III, P06 beamline of DESY, Germany during the period 6-$^{th}$ to 8-$^{th}$ October 2012. Our primary motivation was to find the oxidation states of Eu and Yb because they were expected to be at either divalent or trivalent or even mixed/intermediate states. The ability of these elements in different valence states can be responsible for interesting structural and physical properties. Measurements at the Eu and Yb L$_{III}$ edges at ambient conditions were performed in transmission mode using gas ionization chambers to monitor the incident and transmitted X-ray intensities. Monochromatic X-rays were obtained using a Si (111) double crystal monochromator which was calibrated by defining the inflection point (first derivative maxima) of Cu foil as 8980.5 eV. The beam was focused employing a Kirkpatrick-Baez (K-B) mirror optic. A rhodium coated X-ray mirror was utilized to suppress higher order harmonics. A CCD detector was used to record the transmitted signals. The sample was prepared by mixing an appropriate amount of finely ground powder with cellulose and cold pressing them to a pellet.

We have measured Eu L$_{III}$ edge for the compounds EuCoGe$_3$, Eu$_2$AgGe$_3$, Eu$_2$AuGe$_3$ and Yb L$_{III}$ edge for Yb$_3$Cu$_4$Ge$_4$, Yb$_2$AuGe$_3$, Yb$_2$CuGe$_3$, Yb$_2$CuGe$_6$ and Yb$_3$AuGa$_7$ as shown in figure below.

![Figure 1](image)

Figure 1: (a) Eu L$_{III}$ absorption edge spectra of the compounds EuCoGe$_3$, Eu$_2$AgGe$_3$ and Eu$_2$AuGe$_3$. (b) Yb L$_{III}$ absorption edge spectra of the compounds Yb$_3$Cu$_4$Ge$_4$, Yb$_2$AuGe$_3$, Yb$_2$CuGe$_3$, Yb$_2$CuGe$_6$ and Yb$_3$AuGa$_7$.

The L$_{III}$ - edge spectra of Yb for Yb based compounds are shown in Figure 1b. Yb$_3$Cu$_4$Ge$_4$ shows only one peak at 8946 eV which can be attributed to trivalent Yb; Yb$_3$AuGa$_7$, on the other hand, shows a prominent peak near 8942 eV indicating Yb$^{2+}$ as the dominant valence state. The remaining compounds i.e. Yb$_2$AuGe$_3$, Yb$_2$CuGe$_3$, Yb$_2$CuGe$_6$ show two peaks centered around 8942 and 8946 eV indicating mixed or interivalent states. The XANES data of Yb$_2$AuGe$_3$ corroborates well with our magnetic susceptibility data, mixed valent nature of Yb$_2$CuGe$_6$ and trivalent nature of Yb$_3$Cu$_4$Ge$_4$ is in good agreement with the reported work.
Conclusion

We have verified the valence states of four Eu and Yb based intermetallic compounds through XANES studies. The data matches well with the preliminary magnetic measurements on these compounds. We are interesting to perform dynamic XANES experiments on other new Eu and Yb based intermetallic compounds synthesized in our laboratory since. Most of these compounds show temperature dependent structural phase transitions, which may be associated with valence state transitions. Hence, we recommend to attach facilities for temperature and pressure dependent studies with the P06 beamline at PETRA III.

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Publications


References