ESRF

Experiment title: X-ray emission studies of amorphous FeZr alloys

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Beamline: ID26

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Report:

Experiments at ID26 at the ESRF in April 2008 were initially planned to concern X-ray spectroscopic studies of Te at the $L_{3,2}$ edges. Tc has L-transitions from 2.4 to 2.8 keV which is an energy range available at the ESRF but not at many other synchrotron facilities. However, due to safety regulations the Tc experiment was not allowed and instead the electronic structure of amorphous Zr compounds was studied. Zr L-transitions have comparable energies to those of Tc.

The electronic structure of amorphous systems is a relatively unexplored field with high potentials due to the strong correlation between the electronic structure of materials and their properties. Amorphous materials have interesting properties but their electronic structure is not easily available due to its complex crystal structure. A deeper understanding of the electronic structure of these materials would be of great importance when it comes to designing new materials with desired and exotic properties which might be achievable with amorphous materials.

In amorphous systems local environments of individual iron atoms are different from each other (as opposed to the case of metal systems) giving rise to a sum of different emission lines. Hence, a broadening of emission lines is expected in these systems compared to corresponding metal systems. Hybridization between Fe and Zr states might also give rise to broadening effects.

Non-resonant X-ray emission spectroscopy was used to study the electronic structure in amorphous FeZr alloys and metal Zr at ID26 at the ESRF, Grenoble, France. The results are shown in the figure below. As expected there is a broadening present in the amorphous alloys compared to metal zirconium. The amount of zirconium is twice as large in the alloy containing 85% iron compared to the one containing 93%, hence, the degree of hybridization is significantly higher in the alloy. On the other hand, no significant difference in broadening between the two alloys is visible in the figure. Hence, the broadening is mostly due to structural variations present in the amorphous alloys and not in the metal Zr.

These results are part of a larger work including similar measurements in the soft X-ray energy range on Fe and temperature dependent conductivity measurements which in combination give interesting information about the peculiar properties of these materials. Especially interesting is that there seems to be a localization process going on at scales larger than atomic scales resulting in a semi-conductor like behaviour of the temperature dependence of the conductivity, without the presence of a band gap.

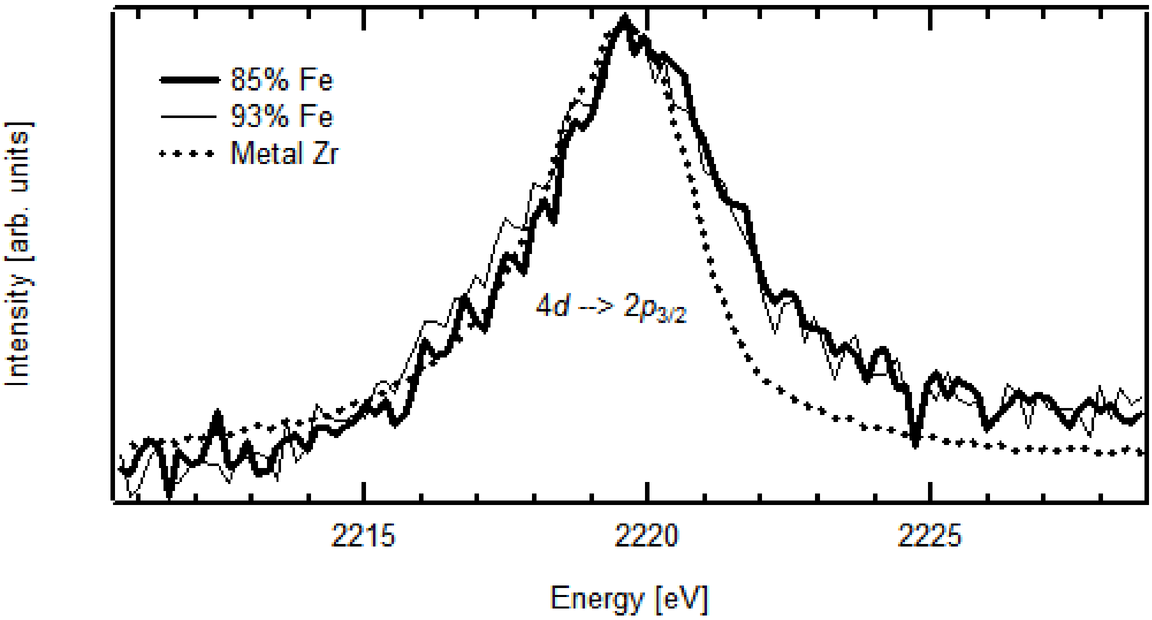

Figure: *Zr L-$\beta_{2,15}$ X-ray emission (4d → 2p transitions) spectra of amorphous FeZr alloys. Sample composition is indicated in the legend.*