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SOFT X-RAY EMISSION STUDIES
OF
SEVERAL ALUMINUM ALLOYS

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Introduction

During the first few months of operation of our soft x-ray spectrometer at the NSLS, we have measured the L emission spectrum for three classes of aluminum alloys:

- a) dilute aluminum magnesium alloys to extend the Al-Mg system to the impurity limit [1],
- b) a 50-50 alloy of aluminum-lithium to characterize the band structure of bulk samples of this potential battery electrolyte [2],
- c) the icosahedral and normal Al-Mn alloys to see if the two phases had measurably different density of states which have been predicted [3].

All spectra shown are produced when core holes generated by energetic electrons or photons are filled by radiative transitions from conduction band states. Dipole selection rules govern the transitions. Thus, K spectra provide a measure of the p-symmetric partial density of states (DOS) near the atom. Similarly, L spectra produced by transitions to p-core holes map the s and d symmetric DOS in the vicinity of the atom with the core hole.

Results

Figure 1 shows the characteristic L spectrum of 98% aluminum in an Al-Mg alloy. This spectrum is essentially identical to the pure aluminum spectrum. The sharp peak at the Fermi edge is attributed to a many body enhancement occurring at both the emission and absorption edges.

In figure 2 we show, on the same energy scale, the aluminum L emission spectrum for 1% aluminum in a Al-Mg alloy. Comparing Fig. 2 with Fig. 1 we note:

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a) the Fermi edge position is shifted by 0.2 eV.,

b) the high energy peak closely replicates the Mg edge peak, and

c) the broad, intense peak extending to the low energy edge of the spectrum provides evidence for the screening charge around the 2:1 aluminum impurity.

Figure 3 is an Al L spectrum obtained from a 50/50 alloy of aluminum in lithium. This spectrum, obtained from bulk samples, is similar to that obtained from evaporated films. The sample we used was slightly lithium rich (51-52% Li, 48-49% Al).

Figure 4 is a spectrum of the aluminum L emission from the icosahedral phase (solid line) and from the mixed phase (dashed line) of the 27% Mn, 73% Al by weight alloy. This spectra are quite different from that of pure aluminum, and there is a measurable difference in the partial DOS for the icosahedral and the more usual phase of this alloy.

Comparing Fig 1-4 we see that the spectra contain a substantial amount information about the local electronic states and electron densities in alloys.

Fig. 1: Al L spectrum characteristic of the pure metal

Fig. 2: Al L emission from 1% Al in 99% Mg

Fig. 3: Al L spectrum from a 50/50 Al-Li alloy

Fig. 4 Spectrum from the icosahedral phase of Al-Mn.

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