

X-ray absorption in metallic Cd in L -edge region

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X-ray absorption in metals has been thoroughly studied since perfectly homogenous high quality absorption specimens with optimum thickness of the order of 10 μm can be routinely prepared. The K edges of metals are often used as intermediary standards for the calibration of energy scale of x-ray monochromators, allowing the accuracy of ~ 0.1 eV or better [1,2]. The softer x-ray region of L edges has received considerably less attention. The optimum thickness of a foil with L edges in the region of 3 – 5 keV is in the 1- μm range, which may be readily available only for extremely ductile metals such as silver [3].

In connection with a study of atomic absorption in the Cd L edge region we tried to prepare a homogeneous Cd metal absorber with optimum thickness [4]. Generally, thinner absorbers can still be used since the accuracy of the measured cross section decreases in proportion to the thickness; too thick absorbers, on the other side, become useless since the intensity of the transmitted beam decreases exponentially with thickness. Besides, the higher harmonics prevail in the transmitted beam, leading to significant systematic errors – as in inhomogeneous samples [5].

The ductility of cadmium is poor, the thinnest foil on stock at Goodfellow is 15 μm , and the success of additional rolling unlikely. Sputtering Cd is also not feasible. Among several approaches two provided good results:

Vacuum evaporation. Cd layers were deposited on 3 μm Al substrate by vacuum evaporation in a vacuum chamber with base pressure of 1×10^{-6} Torr. A resistively heated Ta boat was used to heat a piece of solid Cd, and the thickness of the layers was monitored *in situ* by a quartz thickness monitor. Typical growth rate employed was 10 nm/min. Prior to evaporation the material was thoroughly degassed. During deposition the substrate was at room temperature.

Boron nitride pellet. The micronised boron nitride powder is rubbed on the surface of Cd ingot until a uniform dark grey color is obtained. The powder is pressed into a pellet with surface density of 25 mg/cm^2 in a standard press with 5 bar pressure. A similar approach has been used previously for potassium metal [3].

Cd L -edge spectra of the two Cd metal samples were measured at the C station of HASYLAB in the transmission detection mode. In the beam from Si(111) double-crystal monochromator with 0.8 eV resolution at 3.5 keV, higher-order harmonics were eliminated by detuning the crystals to 50 % of the rocking curve maximum, using beam-stabilization feedback control. The gas fillings of the three ionization detectors optimized for the energy range of 3400 eV to 4500 eV were 235 mbar in the first and 1000 mbar of N_2 in the second and the third one. In the XANES region energy steps of 0.5 eV were used for precise determination of the edge profile, while for the EXAFS region equidistant k -steps (0.03 \AA^{-1}) were adopted with total integration time of 1s/step. The exact energy calibration was established with a simultaneous absorption measurement on 1 μm thick Ag metal foil (Ag L_1 -edge: 3805 eV) between the second and the third ionization chamber.

The absorption scans over the entire L edge region are shown in Fig. 1. The results on the two samples agree perfectly, mutually guaranteeing that both are truly Cd metal, without chemical or structural changes from the preparation. Although the resolution is low due to the short L_3 interval, truncated at $k \sim 6.8 \text{ \AA}^{-1}$, a useful structural signal $\chi(k)$ can be extracted (Fig. 2), yielding the transform $|\chi(R)|$ with the same contributions of consecutive shells of neighbors, as in the K -edge EXAFS of 15 μm thick Cd foil [6].

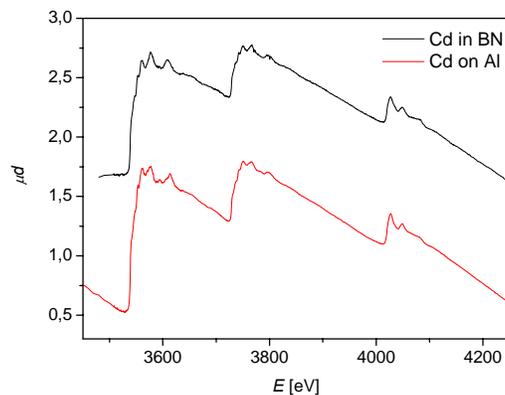


Figure 1: L -edge region X-ray absorption in vacuum-deposited Cd on Al and Cd metal in BN pellet.

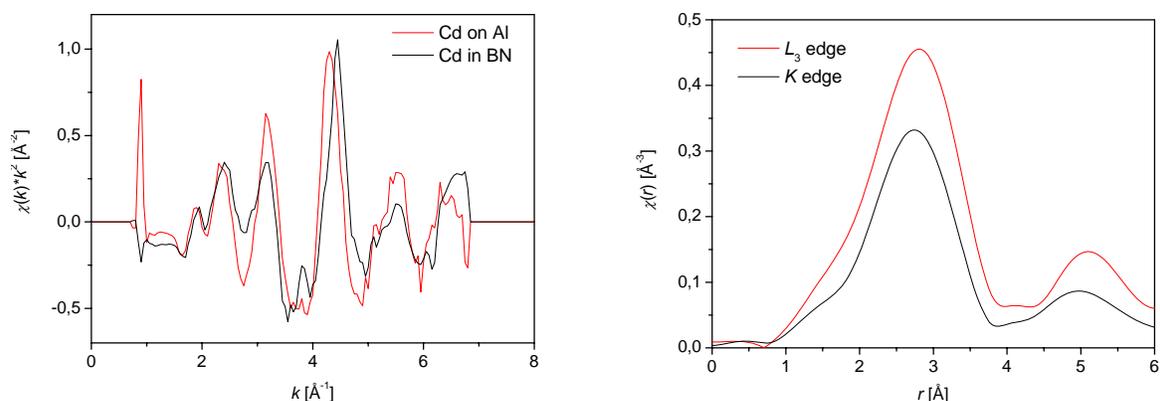


Figure 2: The k^2 weighted Cd L_3 -edge EXAFS spectra of Cd on Al and Cd in BN (**left**), and Fourier transform magnitude of Cd on Al at L_3 edge, and of Cd foil at K edge, from the k range $3.0 - 6.5 \text{ \AA}^{-1}$ (**right**).

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