# Measuring absorption of buried layers utilizing substrate fluorescence as a detector

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## Introduction

Current research is strongly focused on the construction of unique, artificially structured materials such as multi-element heterostructures. These structures consist of a variety of materials prepared in a layered fashion. In many cases, the buried layers are of the most scientific interest; but attempting to study buried layers with soft x-rays (< 3 keV) can sometimes be quite difficult. Most studies utilize either total electron yield (TEY) or fluorescence yield, which have probing depths of 50 Å and 1000 Å, respectively. With both cases it can become necessary to perform corrections to the data in order to extract quantitative information. For example, in applications such as magnetic circular dichroism [1], the extraction of orbital contributions to the magnetic moment can be drastically altered due to probing depth effects [2]. One way to circumvent this problem is to measure the absorption directly in transmission. However, the short mean free path of photons in this energy range makes this difficult in the case of technologically interesting samples. Here we describe an alternative that works by utilizing the fluorescence of underlayer material as a detector [3].

## Methods and Materials

In this case, we utilized the oxygen K-shell fluorescence (524.9 eV) to study Sm and Co absorption in a MgO(100 Å)/Cr(50 Å)/SmCo(350 Å)/Fe(100 Å)/Cr(50 Å) spring magnet structure [4]. All of these measurements were made at the SRI-CAT high-resolution intermediate-energy spectroscopy beamline (2-ID-C). Substrate fluorescence was detected using a wavelength dispersive grating spectrometer with the detector tuned for 20 eV bandpass near the oxygen K fluorescence energy [5].

## Results

To demonstrate the need for this technique, Figure 1 shows the results of a TEY measurement from the buried Co layer. It is clear by comparing a buried vs. an unburied TEY spectrum that aside from some information concerning features in the absorption edge, there is very little that can be quantitatively obtained. However, by monitoring the fluorescence of the oxygen in the substrate, one can measure a transmission spectrum quite well (see Figure 2). Agreement with a simulated transmission demonstrates the capability of this technique to provide true transmission measurements in the soft x-ray regime without having transparent substrates. Not shown due to space considerations are the same transmission spectra for the Sm M edge. In the case of Sm, it was possible to extract the transmission spectrum using not only the oxygen K fluorescence but also using the Co in the layer as a detector by tuning the spectrometer to the Co L-edge fluorescence.

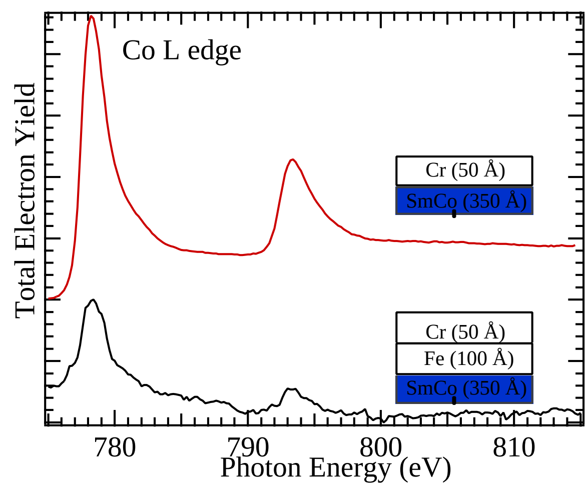


Figure 1: Results of a TEY measurement from the buried Co layer.

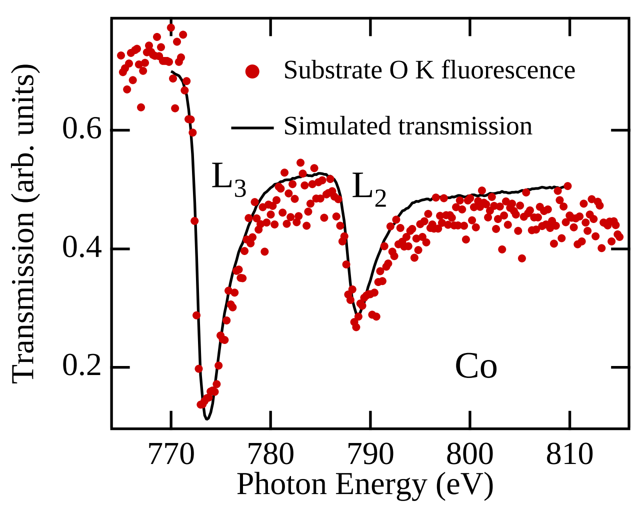


Figure 2: By monitoring the fluorescence of the oxygen in the substrate, a transmission spectrum can be obtained.

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