# X-ray excited optical luminescence studies of oxidized porous silicon


I. Coulthard, J.W. Freeland, and W.J. Antel, Jr.

*Experimental Facilities Division, Argonne National Laboratory, Argonne, IL, 60439 USA*

T.K. Sham, S.J. Naftel, and P. Zhang

*Chemistry Department, University of Western Ontario, London, Ontario, N6A 5B7 Canada*


## Introduction

Porous silicon luminescence [1] has attracted considerable attention for applications in silicon-based opto-electronics [2]. Several porous silicon samples were studied using x-ray excited optical luminescence (XEOL) to examine the optical emission from these samples. Luminescence was also used as a measure of yield to acquire x-ray absorption spectra for the samples. The tunability of the excitation source and the ability to collect the sample luminescence in a wavelength-specific fashion created a highly site-selective experiment. Sources of the optical luminescence for these samples were elucidated. The relative contributions of these different sources of luminescence to the total luminescence from the samples were also determined. As a result, greater understanding of the luminescence sources and luminescence mechanisms for this material was gained.

## Methods and Materials

Porous silicon samples were prepared at the University of Western Ontario. Experiments were performed at the Advanced Photon Source (APS) at the SRI-CAT high-resolution intermediate-energy beamline (2-ID-C). Optical luminescence spectra were collected with a JY H-10 optical monochromator and a Hamamatsu 943-02 cooled photomultiplier tube. Luminescence spectra were collected at constant excitation energy while scanning the optical monochromator. X-ray absorption spectra were recorded in total fluorescence yield (TFY) mode or using the optical luminescence as a measure of the yield. Luminescence yield spectra were collected in total luminescence yield (TLY) mode (in which all luminescence from the sample is analyzed) or in partial luminescence yield (PLY) mode (in which a specific emission wavelength is analyzed).

## Results and Discussion

Figure 1 shows the x-ray absorption data for porous silicon samples exposed to varying levels of oxidation. The absorption spectra for the nonoxidized samples are consistent with those of clean crystalline silicon, indicating a nanocrystalline silicon origin to the luminescence from this sample. The absorption spectra for the oxidized sample, however, shows features consistent with both oxidized and nonoxidized silicon indicating multiple sources of luminescence whose contributions vary greatly depending upon level of oxidation in the sample. A review of the literature has shown that this remarkable change in the luminescence from the samples with changes in oxidation has contributed to past confusion with regard to the source of luminescence from porous silicon.

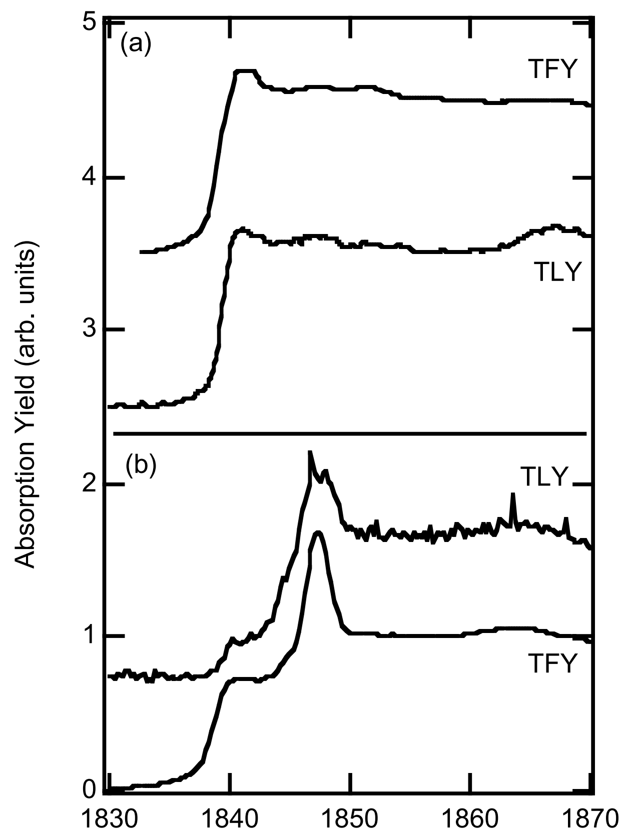


Figure 1: Si K-edge absorption spectra measured in TFY and TLY yield modes for porous silicon samples exposed to (a) no oxidation and (b) heavy wet-chemical oxidation.


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**References**

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