Evans Analytical Group

T050145-00-D

25 Aug 2005

Helena Armandula
California Institute of Technology (Caltech)

Subject: XPS/ESCA Report
EAG Number: C05K4426, Version 2
Purchase Order Number: 75-SOO1389

Dear Ms. Armandula:

Enclosed is the revised final report for the sample(s) submitted for analysis.

Date received:	29 Jul 2005
Results faxed/emailed:	25 Aug 2005 (version 2)
Results emailed to:	ahelena@ligo.caltech.edu
Number of samples:	3
Number of units:	3.00
Priority Surcharge	0%

Your sample(s) will be retained for eight weeks after their receipt. **After this time they will be disposed of, unless you specifically request otherwise.** We will maintain copies of the report and data for three years.

Thank you for using the analytical services of Charles Evans & Associates, a division of the Evans Analytical Group. We appreciate your business and welcome any suggestions you may have for improving the quality and efficiency of our service. Please do not hesitate to call us if you have any questions regarding this report.

Sincerely,

Angela Craig, Ph.D.
Senior Scientist, XPS Services
(Tel. 408-530-3642; Email: acraig@cea.com)

Enclosure

X-RAY PHOTOELECTRON SPECTROSCOPY (XPS)/
ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS (ESCA)
SURFACE ANALYSIS REPORT
25 Aug 2005

EAG NUMBER C05K4426, Version 2
PO NUMBER 75-SOO1389

for

Helena Armandula
California Institute of Technology (Caltech)

Prepared by:

Angela Craig, Ph.D.
Senior Scientist, XPS Services
(Tel. 408-530-3642; acraig@cea.com)

Reviewed by:

Wes Nieveen
Scientific Fellow
(Tel. 408-530-3756; wnieveen@cea.com)

Charles Evans & Associates
810 Kifer Rd
Sunnyvale, CA 94086 USA

TEL 408-530-3500
FAX 408-530-3501

XPS/ESCA ANALYSIS LABORATORY REPORT

Requester: Helena Armandula
EAG Number: C05K4426, Version 2
Analysis Date: 25 Aug 2005

Purpose:

This is version 2 of the report for the XPS/ESCA analysis of a glass sample. The original version of the report provided results for one spot on the Haze Side and one spot on the Control Side. This version includes an additional spot on the Haze Side of the glass.

The goal of this analysis was to compare the surface elemental composition of both sides of a glass sample. Side 1 had a milky haze and is referred to as “the Haze Side.” Side 2 is referred to as “Control Side.”

Summary:

The glass is composed of Si, O, and C with low levels of Na. The most significant difference in the composition of the two surfaces of the glass is the higher Na concentrations on the Haze Side in both locations (see Table 1), which are more than 3 times the amount seen on the Control side.

Experimental:

XPS data is quantified using relative sensitivity factors and a model that assumes a homogeneous layer. The analysis volume is the product of the analysis area (spot size or aperture size) and the depth of information. Photoelectrons are generated within the X-ray penetration depth (typically many microns), but only the photoelectrons within the top three photoelectron escape depths are detected. Escape depths are on the order of 15-35 Å, which leads to an analysis depth of ~50-100 Å. Typically, 95% of the signal originates from within this depth.

Analytical Parameters

Instrument	PHI Quantum 2000
X-ray source	Monochromated Alk$_{\alpha}$ 1486.6eV
Acceptance Angle	$\pm 23^{\circ}$
Take-off angle	45°
Analysis area	1400μm x 300μm

Results and Discussion:

Survey spectra are found in the attached figures. Sample names are provided in the title box of each spectrum. Table 1 provides the atomic concentrations of the elements detected. XPS does not detect H or He. Values given are normalized to 100% using the elements detected.

Detection limits are approximately 0.05 to 1.0 atomic %. Major factors affecting detection limits are the element itself (heavier elements generally have lower detection limits), interferences (can include photoelectron peaks and Auger electron peaks from other elements) and background (mainly caused by signal from electrons that have lost energy to the matrix).

1. Both surfaces of the glass are composed of primarily O, Si, and C, with lower levels of Na also detected (see Table 1). A trace of N is also present on the Haze Side, Spot 2 and on the Control Side.

2. The most significant difference between the Haze Side and the Control Side is the higher levels of Na on the Haze Side in both locations on the Haze Side. Note that there is a statistically significant difference in Na between the two locations on the Haze Side, but it is unclear how or why this would produce or affect the observed haze.

3. Carbon is observed on most surfaces analyzed by XPS and is largely due to contamination from exposure to the atmosphere. The levels of C detected on the glass surfaces are considered moderate and typical for 'adventitious' C.

After reviewing this report, you may assess our services using an electronic service evaluation form. This can be done by clicking on the link below, or by pasting it into your internet browser. Your comments and suggestions allow us to determine how to better serve you in the future. http://www.eaglabs.com/evaluate.htm?job=C05K4426

Table 1: Atomic Concentrations (in %)[a]

Sample	C	N	O	Na	Si
Haze Side (Side 1), Spot 1	21.0	-[b]	55.0	2.7	21.3
Haze Side (Side 1), Spot 2	20.1	0.6	55.3	3.2	20.9
Control (Side 2)	17.8	0.5	58.9	0.1	22.8

[a] Normalized to 100% of the elements detected. XPS does not detect H or He.
[b] A dash line "-" indicates the element is not detected.

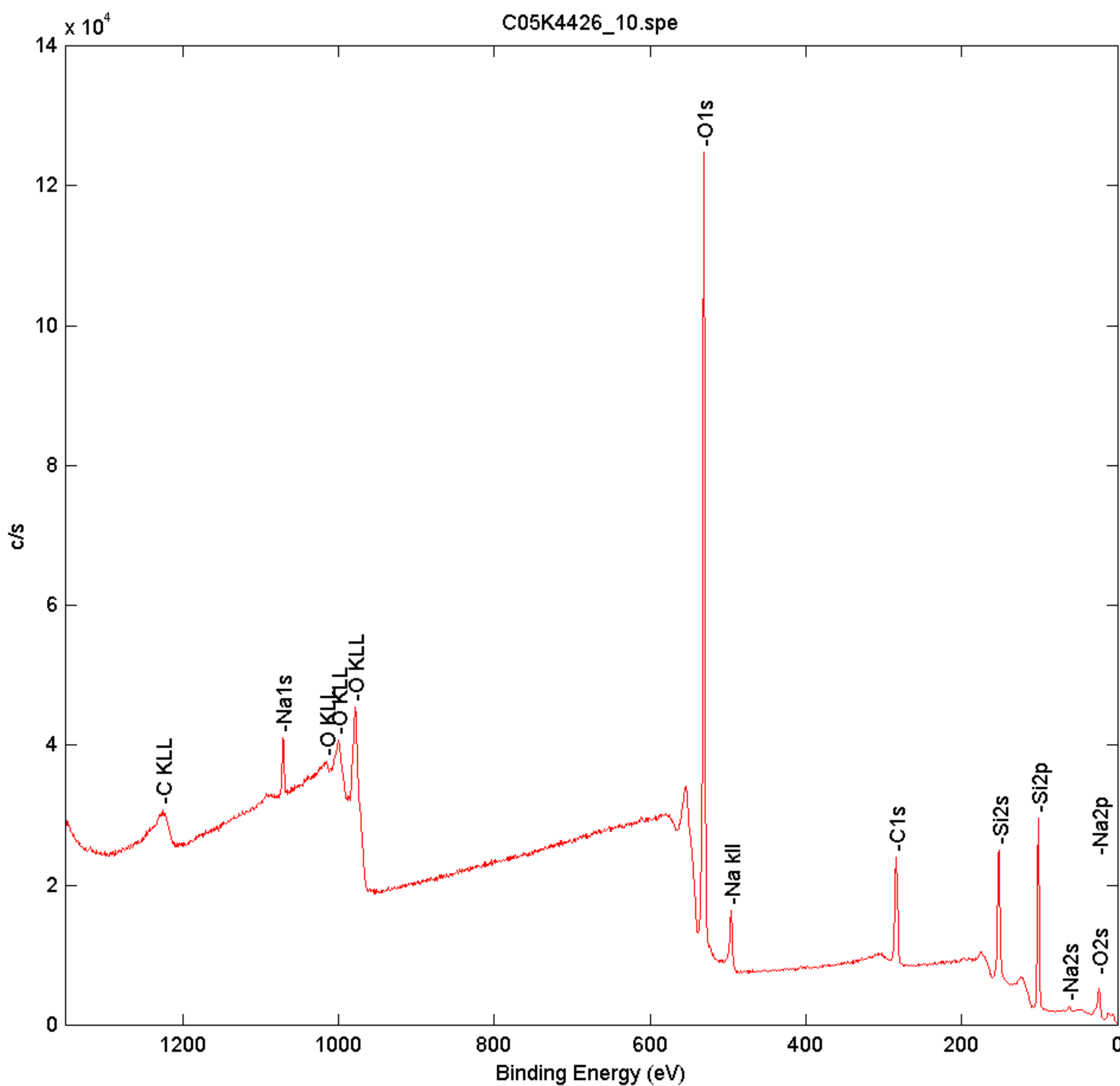

Figure 1

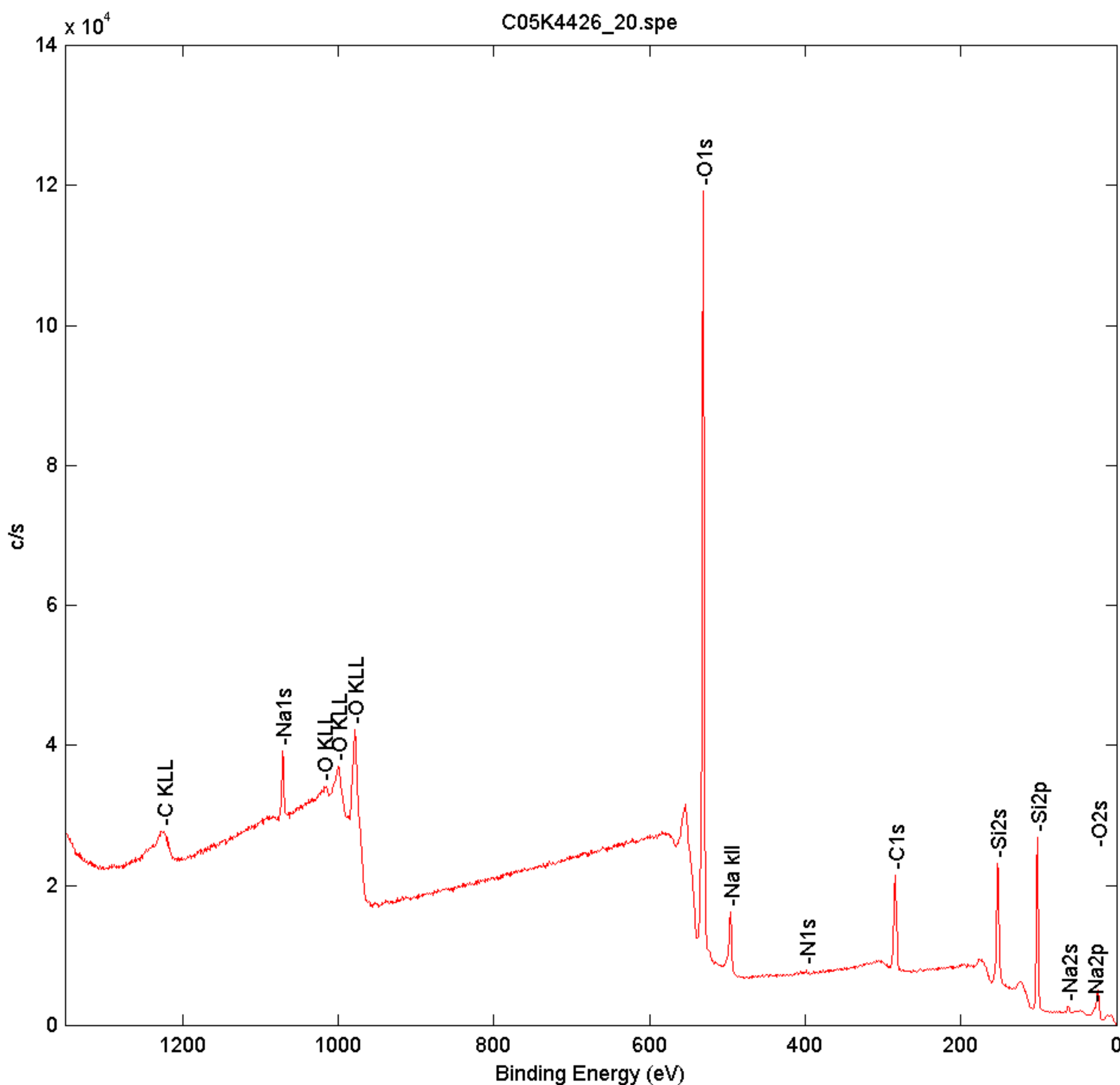

Figure 2

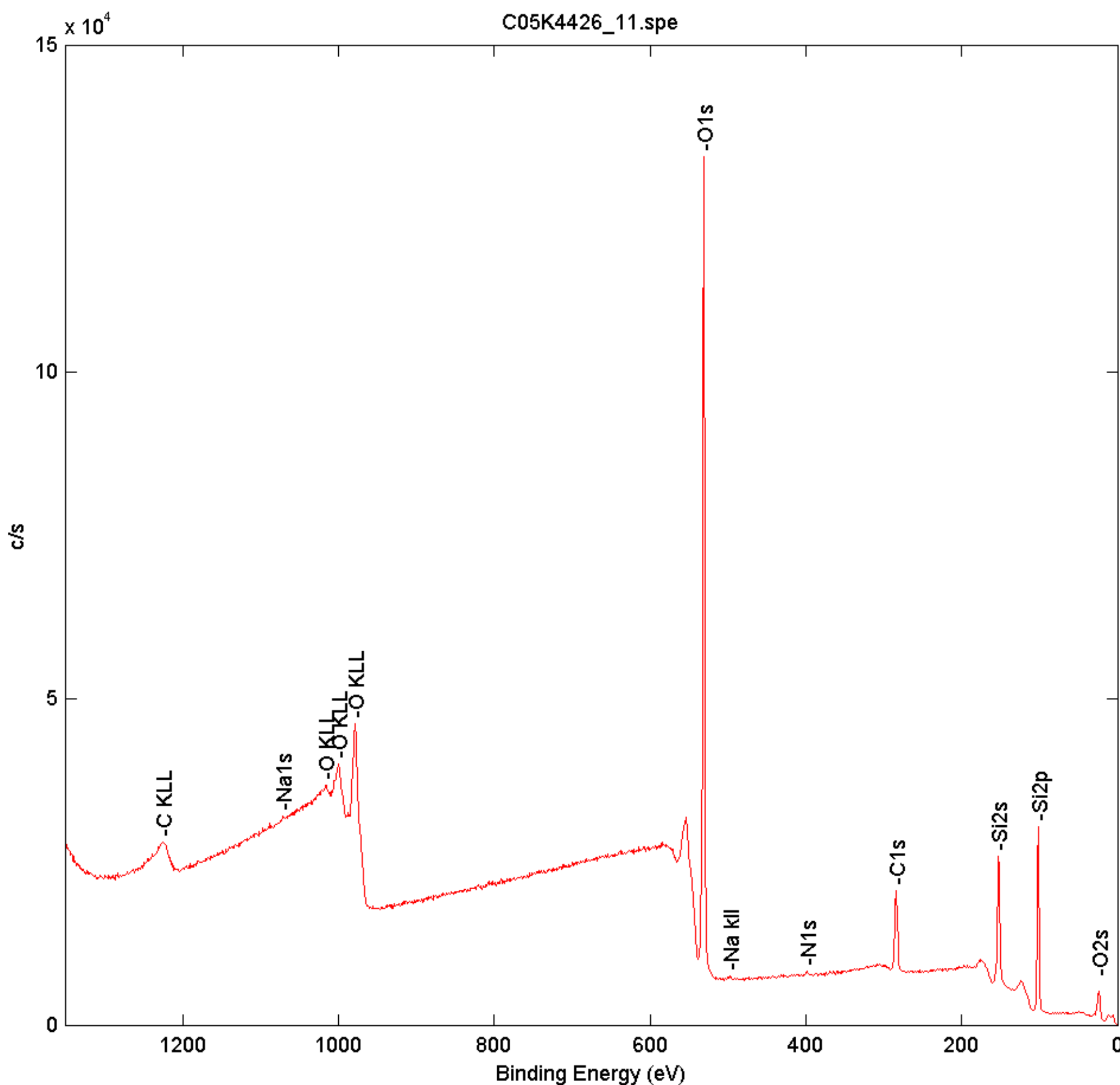

Figure 3