Legend to Spectra Pages

The following pages explain the information contained on the pages of each data set.

Legend to Spectra Pages

The following pages explain the information contained on the pages of each data set.

Demo Version (172 pages)
PDF Handbooks of Monochromatic XPS Spectra

Volume 2 – *Commercially Pure Binary Oxides* (Ag-B, Zn-Zr only)

and a few Common Carbonates and Hydroxides

by

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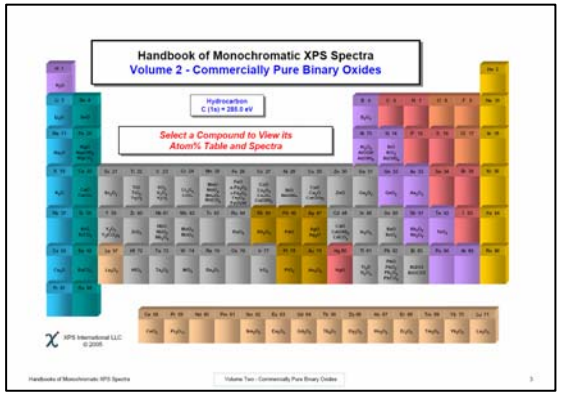
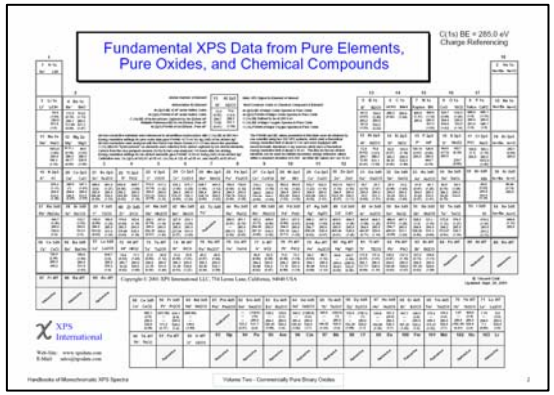
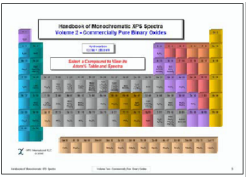


Periodic Table Index

Alphabetical Index (AgO - ZrO_2)



Fundamental XPS Data



Fundamental XPS Data from Pure Elements, Pure Oxides, and Chemical Compounds

Atomic Number of Element — Abbreviation for Element — Al (2p3) BE of Al° under Native Oxide — Al (2p3) FWHM of Al° under Native Oxide — C (1s) BE of Hydrocarbons Captured by Ion Etched Al° — Reliable Reference BE for Ion Etched, Pure Al° — Al (2p3) FWHM of Ion Etched , Pure Al°

Main XPS Signal for Element of Interest — Most Common Oxide or Chemical Compound of Element — Al (2p3) BE of Major Oxide Species in Pure Oxide — Al (2p3) FWHM of Major Oxide Species in Pure Oxide — C (1s) BE Defined to be at 285.0 eV — O (1s) BE of Major Oxygen Species in Pure Oxide — O (1s) FWHM of Major Oxygen Species in Pure Oxide

13 Al 2p3	
Al°	Al2O3
72.9 (0.62) 284.7 72.82 (0.41)	75.6 (1.41) 286.3 531.1 (1.56)

All non-conductive materials were referenced to adventitious hydrocarbon with C (1s) BE at 285.0eV. Energy resolution settings for pure oxide data gave FWHM <0.75 eV for Ag (3d5) of ion etched Ag°. All non-conductors were analyzed with the Flood-Gun Mesh-Screen 0.5-1.0 mm above the specimen. C (1s) BEs for "hydrocarbons" on elements were collected from carbon captured by ion etched elements. Carbon from the cryo-pumped vacuum (3x10(-9) torr) was analyzed >10 hours after ion etching. Energy resolution settings for ion etched elements gave FWHM <0.50 eV forAg (3d5) of ion etched Ag°. Calibration was: Cu (2p3) at 932.67 ±0.05 eV, Cu (3s) at 122.45 ±0.05 eV, and Au(4f7) at 83.98 eV.

The FWHM and BE values presented in this table were all obtained by one scientist using two SSI XPS systems, which yield a theoretical energy resolution limit of about 0.1 eV and were equipped with monochromatic Aluminum X-ray sources which have a theoretical energy resolution limit of about 0.16 eV. The BEs for the ion etched elements can be used as reliable secondary energy reference values within a standard deviation of 0.055. All other BE values are <±0.15 eV.

1	2																	18
1 H 1s H2° LiH												13	14	15	16	17		2 He 1s He+/Be He+/C
3 Li 1s Li° LiOH 54.9 (1.65) 285.0 531.8 (1.6)	4 Be 1s Be° BeO 111.9 (0.79) 286.1 111.88 (0.69) 113.6 (1.73) 285.0 531.3 (1.47)											5 B 1s B° B2O3 187.5 (0.87) 285.2 187.8 (1.03) 194.0 (2.40) 285.0 532.5 (2.22)	6 C 1s HOPG Black 284.5 (0.42) 284.4 (1.04)	7 N 1s Kapton BN 400.9 (1.31) 285.0 398.9 (1.10) 285.0 191.3 (1.03)	8 O 1s CuO SiO2 529.7 (0.98) 284.9 934.0 (1.42) 532.5 (1.40) 285.0 103.0 (1.14)	9 F 1s Teflon CaF2 688.9 (1.8) 285.0 291.9 (1.6) 685.1 (1.53) 285.0 348.1 (1.6)	10 Ne 1s Ne+/Be Ne+/C
11 Na 1s Na° NaCl 1072.0 (1.40) 285.0 199.3 (1.19)	12 Mg 2p Mg° MgO 51.5 7 (0.58) 286.5 49.77 (0.60) 49.5 (1.63) 285.0 529.8 (1.99)											13 Al 2p3 Al° Al2O3 72.9 (0.62) 284.7 72.82 (0.41) 75.6 (1.41) 286.3 531.1 (1.56)	14 Si 2p3 Si° SiO2 99.8 (0.57) 285.3 99.35 (0.45) 103.0 (1.14) 285.0 532.5 (1.40)	15 P 2p3 P° InP 130.13 (0.67) 285.0 128.8 (0.62) 285.0 444.7 (0.78)	16 S 2p3 S° MoS2 164.0 (0.72) 285.0 162.7 (0.39) 229.7 (0.80)	17 Cl 2p3 PVC NaCl 199.8 (1.7) 285.0 199.3 (1.19) 285.0 1072.0 (1.40)	18 Ar 2p3 Ar+/Be Ar+/C 242.1 (0.90) 285.0
19 K 2p3 K° KI 293.2 (1.11) 285.0 619.2 (1.30)	20 Ca 2p3 Ca° CaO 346.5 (?) 284.6 346.5 (1.07) 347.1 (1.81) 285.0 531.5 (1.57)	21 Sc 2p3 Sc° Sc2O3 398.6 (0.9) 285.8 398.46 (0.69) 401.9 (1.27) 285.0 530.0 (1.33)	22 Ti 2p3 Ti° TiO2 453.8 (0.90) 285.2 453.95 (0.62) 458.7 (1.09) 285.0 530.0 (1.18)	23 V 2p3 V° V2O5 512.2 (0.79) 285.0 512.22 (0.75) 517.3 (1.32) 285.0 530.2 (1.33)	24 Cr 2p3 Cr° Cr2O3 574.2 (1.05) 284.6 574.37 (0.89) 575.7 (1.20) 285.0 530.1 (1.24)	25 Mn 2p3 Mn° MnO2 638.7 (1.00) 286.4 638.74 (0.89) 641.5 (1.12) 285.0 529.5 (1.02)	26 Fe 2p3 Fe° Fe2O3 706.6 (0.90) 284.9 706.78 (0.99) 709.8 (1.32) 285.0 532.9 (1.05)	27 Co 2p3 Co° Co3O4 778.1 (0.99) 284.9 778.26 (0.85) 779.5 (1.39) 285.0 530.1 (1.00)	28 Ni 2p3 Ni° NiO 852.6 (1.14) 284.8 852.65 (1.02) 853.8 (1.42) 285.0 529.4 (1.03)	29 Cu 2p3 Cu° Cu2O 932.7 (1.22) 284.6 932.68 (0.92) 932.5 (1.10) 285.0 530.5 (1.01)	30 Zn 2p3 Zn° ZnO 1021.8 (1.10) 284.8 1021.76 (0.97) 1021.7 (1.50) 285.0 530.5 (1.11)	31 Ga 3d5 Ga° Ga2O3 18.7 (0.70) 285.0 18.5 (0.60) 20.7 (1.37) 285.0 531.3 (1.51)	32 Ge 3d5 Ge° GeO2 29.3 (0.68) 285.0 29.28 (0.64) 33.2 (1.49) 285.0 532.2 (1.40)	33 As 3d5 As° As2O3 41.8 (0.67) 284.5 41.69 (0.67) 45.1 (1.26) 285.0 532.0 (1.41)	34 Se 3d5 Se° SeOx 54.8 (0.76) 284.2 54.90 (0.78) 59.3 (1.09) 285.0 532.6	35 Br 3d5 KBr 68.8 (0.92) 285.0 293.0 (1.31)	36 Kr 3d5 Kr+/Be Kr+/C 86.94 (0.79) 285.0
37 Rb 3d5 Rb° RbOAc 109.7 (1.40) 285.0 530.9 (1.6)	38 Sr 3d5 Sr° SrCO3 133.7 (1.63) 285.0 531.5 (1.9)	39 Y 3d5 Y° Y2O3 155.9 (0.80) 286.0 155.92 (0.62) 156.6 (1.25) 285.0 531.0 (1.30)	40 Zr 3d5 Zr° ZrO2 179.0 (0.90) 285.3 178.80 (0.63) 182.4 (1.18) 285.0 530.3 (1.39)	41 Nb 3d5 Nb° Nb2O5 202.1 (0.78) 285.0 202.35 (0.57) 207.4 (1.14) 285.0 530.4 (1.36)	42 Mo 3d5 Mo° MoO3 227.8 (0.66) 285.4 227.94 (0.57) 233.1 (1.05) 285.0 531.0 (1.20)	43 Tc 3d5 Tc° Radioactive	44 Ru 3d5 Ru° RuO2 280.0 (0.67) --- 280.11 (0.59) 281.1 (0.79) 285.0 529.7 (0.95)	45 Rh 3d5 Rh° Rh2O3 307.2 (0.73) 284.05 307.21 (0.69) 308.9 (0.80) 285.0 530.5 (1.05)	46 Pd 3d5 Pd° PdO 335.1 (0.86) 284.5 335.10 (0.77) 337.0 (0.97) 285.0 530.7 (1.35)	47 Ag 3d5 Ag° Ag2O 368.2 (0.64) 284.7 368.28 (0.62) 367.5 (1.00) 285.0 529.4 (0.97)	48 Cd 3d5 Cd° CdO 405.0 (0.90) 285.0 405.04 (0.61) 404.0 (1.38) 285.0 528.6 (1.28)	49 In 3d5 In° In2O3 443.8 (1.08) 284.9 443.87 (0.71) 444.3 (1.26) 285.0 529.9 (1.19)	50 Sn 3d5 Sn° SnO2 484.9 (0.81) 284.7 485.01 (0.68) 487.3 (1.28) 285.0 531.1 (1.29)	51 Sb 3d5 Sb° Sb2O5 528.2 (1.0) 284.6 528.26 (0.80) 530.4 (1.10) 285.0 531.3 (0.86)	52 Te 3d5 Te° TeO2 572.8 (1.12) 284.2 572.97 (0.83) 576.5 (1.27) 285.0 530.7 (1.39)	53 I 3d5 KI 619.2 (1.30) 285.0 293.2 (1.11)	54 Xe 3d5 Xe+/Be Xe+/C 669.6 (1.13) 285.0
55 Cs 3d5 Cs° CsCl 724.6 (2.08) 285.0 199.2	56 Ba 3d5 Ba° BaOAc 780.0 (1.80) 285.0 531.4 (1.83)	57 La 3d5 La° La2O3 834.7 (3.0) 285.0 529.2 (1.6)	72 Hf 4f7 Hf° HfO2 14.4 (0.63) 285.7 14.32 (0.62) 17.1 (1.26) 285.0 530.5 (1.68)	73 Ta 4f7 Ta° Ta2O5 21.8 (0.80) 285.0 21.78 (0.56) 26.8 (1.12) 285.0 531.0 (1.46)	74 W 4f7 W° WO3 31.4 (0.58) 285.3 31.38 (0.53) 35.8 (1.01) 285.0 530.6 (1.27)	75 Re 4f7 Re° Re2O7 40.3 (0.67) 285.3 40.30 (0.54) 46.8 (1.64) 285.0 532.1 (1.58)	76 Os 4f7 Os° OsO4	77 Ir 4f7 Ir° IrO2 60.8 (0.80) 284.4 60.88 (0.82) 62.0 (0.98) 285.0 530.2 (0.97)	78 Pt 4f7 Pt° PtO2 71.0 (0.96) 284.3 71.15 (0.88) 75.1 (1.16) 285.0 531.3 (1.74)	79 Au 4f7 Au° Au2O3 84.1 (0.83) 284.1 83.98 (0.68) 88.1 (1.12) 285.0 531.6 (1.13)	80 Hg 4f7 Hg° HgO 99.8 --- 285.0 99.81 (0.65) 100.7 (1.06) (285.0) 532.9 (0.96)	81 Tl 4f7 Tl° Tl2O3 117.8 (0.97) 285.1 117.77 (0.66) 117.4 (1.01) 285.0 528.9 (1.10)	82 Pb 4f7 Pb° PbO 136.9 (0.67) 284.9 136.95 (0.63) 137.5 (1.10) 285.0 528.9 (1.07)	83 Bi 4f7 Bi° Bi2O3 157.0 (0.73) 284.6 157.05 (0.62) 158.8 (1.11) 285.0 529.6 (1.58)	84 Po 4f7 Radioactive	85 At 4f7 Radioactive	86 Rn 4f7 Radioactive
87 Fr 4f7 Radioactive	88 Ra 4f7 Radioactive	89 Ac 4f7 Radioactive																

B. Vincent Crist
Updated: Sept. 20, 2001

58 Ce 3d5 Ce° CeO2 882.1 (2.0) 285.0 529.6 (2.00)	59 Pr 3d5 Pr° Pr2O5 (931.98) --- 111.2 (2.17) 933.1 (4.4) 285.0 528.2 (1.4)	60 Nd 3d5 Nd° Nd2O3 (980.86) --- --- 118.0 (1.80)	61 Pm 4d5 Pm° Pm2O3 Radioactive	62 Sm 4d5 Sm° Sm2O3 --- --- --- 123.2 (2.5?) (134.9) (10) 285.0 531.7 (2.4)	63 Eu 4d5 Eu° Eu2O3 128.2 --- (3.7) 284.3 285.0 128.18 (1.08) 135.6 285.0 529.2 (1.4)	64 Gd 4d5 Gd° Gd2O3 140.2 (1186.8) --- (5.4) 281.4 285.0 140.33 (1.02) 529.0 (1.7)	65 Tb 4d5 Tb° Tb3O7 145.9 (149.9) --- (?) --- 285.0 146.02 (1.33) 529.5 (1.6)	66 Dy 4d5 Dy° Dy2O3 152.4 (156.1) --- (?) --- 285.0 152.30 (1.88) 529.2 (1.7)	67 Ho 4d5 Ho° Ho2O3 159.8 161.3 --- ((6.0) --- 285.0 159.58 (1.50) 529.3 (1.7)	68 Er 4d5 Er° Er2O3 167.7 168.5 --- (3.8) --- 285.0 167.25 (1.93) 529.2 (1.9)	69 Tm 4d5 Tm° Tm2O3 175.3 176.3 --- (3.4) 285.3 285.0 175.37 (1.92) 529.6 (1.7)	70 Yb 4f7 Yb° Yb2O3 1.07 184.9 --- (3.4) 285.6 285.0 (182.39) 529.4 (0.61) (2.0)	71 Lu 4f7 Lu° Lu2O3 7.10 8.4 --- (3.0) 284.6 285.0 7.1 (0.69) (1.8)
90 Th 4f7 Th° ThO2	91 Pa 4f7	92 U 4f7 U° U2O3	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
	Radioactive		Radioactive	Radioactive	Radioactive	Radioactive	Radioactive	Radioactive	Radioactive	Radioactive	Radioactive	Radioactive	Radioactive

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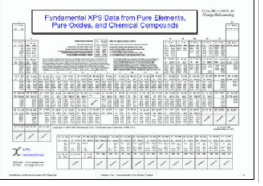


Handbook of Monochromatic XPS Spectra
Volume 2 - Commercially Pure Binary Oxides

Hydrocarbon
C (1s) = 285.0 eV

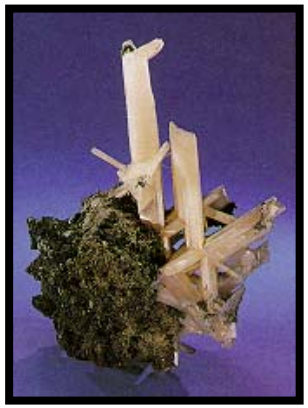
Select a Compound to View its Atom% Table and Spectra

H 1																He 2
H_2O																
Li 3	Be 4										B 5	C 6	N 7	O 8	F 9	Ne 10
Li_2O	BeO										B_2O_3					
Na 11	Fe 26										Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
Na_2O	MgO $Mg(OH)_2$ $MgCO_3$										Al_2O_3 AlOOH $Al(OH)_3$	SiO SiO_2 $Si(OH)_4$				
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
K_2O	CaO $CaCO_3$	Sc_2O_3	TiO TiO_2 Ti_2O_3	VO_2 V_2O_3 V_2O_5	Cr_2O_3 CrO_3	MnO MnO_2 Mn_2O_3 $MnCO_3$	FeO α-Fe_2O_3 γ-Fe_2O_3 Fe_3O_4 FeOOH	CoO . Co_3O_4 $Co(OH)_2$	NiO $Ni(OH)_2$	CuO Cu_2O $Cu(OH)_2$	ZnO	Ga_2O_3	GeO_2	As_2O_3			
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
	SrO $SrCO_3$	Y_2O_3 $Y_2(CO_3)_3$	ZrO_2	NbO NbO_2 Nb_2O_5	MoO_2 MoO_3		RuO_2	Rh_2O_3	PdO	AgO Ag_2O	CdO $Cd(OH)_2$ $CdCO_3$	In_2O_3	SnO SnO_2	Sb_2O_3 Sb_2O_5	TeO_2		
Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
Cs_2O	$BaCO_3$	La_2O_3	HfO_2	Ta_2O_5	WO_3	Re_2O_7		IrO_2	PtO_2	Au_2O_3	HgO	. Tl_2O_3	PbO PbO_2 Pb_2O_3 $PbCO_3$	Bi2O3 BiOCO3			
Fr 87	Ra 88																

Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71
CeO_2	Pr_6O_{11}			Sm_2O_3	Eu_2O_3	Gd_2O_3	Tb_4O_7	Dy_2O_3	Ho_2O_3	Er_2O_3	Tm_2O_3	Yb_2O_3	Lu_2O_3

Cassiterite, SnO_2, black

Cuprite, Cu_2O, red



Cerrusite, $PbCO_3$, white

Anatase, TiO_2, black

Rhodochrosite, $MnCO_3$, red

Tenorite, CuO, black

Tellurite, TeO_2, yellow

Calcite, $CaCO_3$, yellow

Hematite, α-Fe_2O_3, brown

Diaspore, AlOOH, white

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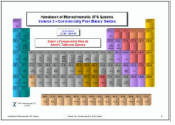

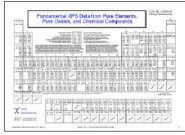

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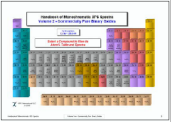
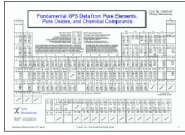
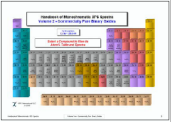
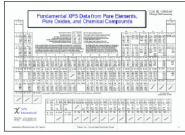


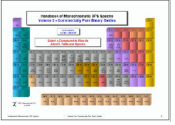


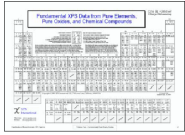


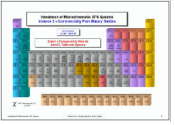


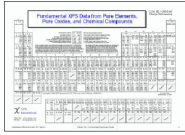
Alphabetical List of XPS Spectra in Volume Two

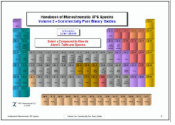
Binary Oxides, Carbonates and Hydroxides – Alphabetical by Chemical Formula

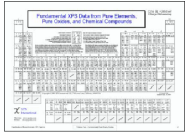












INTRODUCTION

This handbook contains wide scan survey spectra and high energy resolution narrows scan spectra from commercially pure samples of binary oxides, a few natural minerals, several hydroxides and carbonates. The spectra were collected under conditions that maximized the accuracy and reliability of the binding energies. The reference energies used to calibrate the energy scale were those reference energies recommended by the National Physical Laboratory in the UK, and now ISO TC/201. Section "F" provides the details of energy scale calibration. For those compounds that were non-conductive or semi-conductive in behavior, the reference energy for the hydrocarbon carbon (1s) signal from those samples was defined as 285.0 eV. The binding energies of all truly conductive samples were reported exactly as measured and without correction.

ORGANIZATION AND DETAILS OF SPECTRAL SETS

Organization

The spectra are organized alphabetically by using the chemical formula (e.g. AgO to ZrO_2). Data and spectra from the binary oxide known as "aluminum (III) oxide" has chemical formula "Al_2O_3" in the upper right and left corners of the pages that belong to that set of spectra. This means that spectra and data for "Antimony Oxide" will be found by looking for the chemical formula: "Sb_2O_3". Just underneath of this chemical formula the mineral name is reported if the sample was a natural mineral.

Contents of Each Set of Spectra

The compounds in this volume include: AgO, Ag_2O, Al_2O_3, $Al(OH)_3$, AlOOH (Diaspore), As_2O_3, Au_2O_3, B_2O_3, $BaCO_3$, BeO, Bi_2O_3, $(BiO)_2CO_3$, CaO, $CaCO_3$ (Calcite), CdO, $Cd(OH)_2$, $CdCO_3$, CeO_2, CoO, Co_2O_3, Co_3O_4, $Co(OH)_2$, CrO_3, Cr_2O_3, Cs_2O, CuO, Cu_2O (Cuprite), $Cu(OH)_2$, $CuCO_3$ (Azurite), Dy_2O_3, Er_2O_3, Eu_2O_3, FeO, α-Fe_2O_3 (Hematite), γ-Fe_2O_3, Fe_3O_4, FeOOH (Goethite), Ga_2O_3, Gd_2O_3, GeO_2, HfO_2, HgO, Ho_2O_3, In_2O_3, IrO_2, K_2O, La_2O_3, Li_2O, Li_2CO_3, Lu_2O_3, MgO, $Mg(OH)_2$, $MgCO_3$, MnO, MnO_2, Mn_2O_3, $MnCO_3$ (Rhodochrosite), MoO_2, MoO_3, Na_2O, NbO, NbO_2, Nb_2O_5, NiO, $Ni(OH)_2$, PbO, PbO_2, Pb_2O_3, $PbCO_3$ (Cerrusite), PdO, Pr_6O_{11}, PtO_2, Re_2O_7, Rh_2O_3, RuO_2, Sb_2O_3, Sb_2O_5, Sc_2O_3, SiO, SiO_2 (Quartz), $Si(OH)_4$ (Opal), Sm_2O_3, SnO, SnO_2 (Cassiterite), $SrCO_3$, SrO, Ta_2O_5, Tb_4O_7, TeO_2, ThO_2, TiO, TiO_2, Ti_2O_3, Tl_2O_3, Tm_2O_3, VO_2, V_2O_3, V_2O_5, WO_3, Y_2O_3, $Y_2(CO_3)_3$, Yb_2O_3, ZnO, and ZrO_2.

The first page of each data set includes a title line that reports the chemical name, the oxidation state of the element, and its' formula weight (FW). Just below the title line the "Surface Composition Table" lists the peak assignments from each wide scan survey spectrum, corrected and measured binding energies of all major and minor peaks, relative sensitivity factors, relative peak areas and the atom % abundance of each major signal. Each data set includes a wide scan survey spectrum, a valence band spectrum, a 1,000-1,400 eV range spectrum and high energy resolution spectra of the

primary metal signal, secondary metal signals, the carbon (1s) signal, the oxygen (1s) signal and several Auger signals. The spectra and their annotations are presented exactly as produced and exported by the Spectral Data Processor v4.1 software from XPS International LLC.

Descriptions above each subsequent spectrum include the original key information about the sample, the source of the sample if known, and peak labels. Detailed information about the operating capabilities of the SSI XPS system and analysis conditions used to collect these data are presented in the next section of this book.

The remaining pages of each set include the high energy resolution narrow scan spectra which were obtained by measuring the main XPS signals found in the wide scan survey spectrum. These spectra contain detailed peak-fit results in a table at the top left corner of the spectrum and the actual peak-fit results. The binding energies of the non-conductive samples were corrected to the binding energy of the hydrocarbon carbon (1s) signal at 285.0 eV which is a common practice. This method of energy referencing non-conductive materials is widely used and accepted because there is currently no standard method for charge referencing spectra from insulating materials. Each peak-fit table includes the binding energies of each peak, their FWHM, peak height, percentage of Gaussian peak-shape used, percentage of asymmetry used, normalized peak area and relative peak area. The relative peak area percentages are based on the total peak area intensity of that signal only. Relative peak area percentages are not atom % values.

Philosophy of Data Collection

The spectra in this book were collected under analysis conditions that are practical, readily reproduced, and typically used in laboratories that use monochromatic X-ray sources and are working under real world practical analysis conditions. We have produced this volume of reference spectra because many XPS laboratories need practical reference spectra and do not have the time or money to produce XPS spectra from common reference materials. The signal to noise (S/N) ratios in the wide scan survey spectra is large enough to reveal the presence of minor components that are often not detected. The high energy resolution spectra were obtained under analysis conditions that would give a FWHM = 0.75 eV from the Ag ($3d_{5/2}$) signal of freshly ion etched silver (Ag).

A few high energy resolution spectra, labeled with the superscript “UR” were obtained under the “ultimate energy resolution” conditions available on the SSI S-Probe XPS system. This “ultimate” level of energy resolution produced a FWHM = 0.44 eV from the ($3d_{5/2}$) signal of freshly ion etched silver (Ag). In the production of these spectra we did not attempt to clean the surfaces of any sample because that would make charge referencing of the non-conductive samples a difficult task. For practical reasons we used the hydrocarbon carbon (1s) spectra from the naturally formed layer of adventitious hydrocarbons for charge referencing because that signal is the “de facto” standard for charge referencing non-conductive materials. This method of correcting for charge-up increases the uncertainty in the accuracy of the related binding energies.

The spectral data contained within this 5 volume series of handbooks are designed to assist engineers, scientists, analysts, theoreticians, and teachers who use XPS on an everyday basis under practical working conditions. We hope that these spectra will help XPS users to analyze industrial problems, gather high grade reference data, perform basic research, test theories and teach others. These spectra are designed to be practical tools for everyday

use and were obtained under practical working conditions. We have not attempted to produce research grade spectra, but we have, in fact, produced research grade spectra because of our self-consistent methods. In the production of these spectra no attempt was made to produce a pure, clean surface, but an effort was made to produce surfaces with a minimum amount of natural surface contamination.

Peak-Fitting (Curve-Fitting) of High Energy Resolution Spectra

Peak-fitting was performed by using Spectral Data Processor (SDP v4.1) from XPS International LLC (www.xpsdata.com). This software allows the user to control the full width at half maxima (FWHM) value of any peak, the binding energy (BE) of any peak, peak areas, peak heights, the ratio of pairs of peak areas, the ratio of pairs of FWHM, the energy difference between two peak maxima, the shape of a peak as a sum-function of Gaussian and Lorentzian peak shapes, and the percentage of asymmetry in any peak.

By empirically peak-fitting the spectra from large sets of closely related materials in a trial and error method and analyzing the trends, it was possible to recognize several fundamental peak-shape and peak-fitting parameters for pure elements, binary oxides, polymers, and semiconductors. We have used those empirical findings to guide our efforts to peak-fit the many spectra which had complicated peak shapes. In some cases we used the theoretical peak area ratio of a spin-orbit coupled pair to assist the peak-fitting of a spectrum, and also the energy interval between spin-orbit coupled signals derived from pure element spectra.

The reduced “chi-squared” value, which indicates the goodness of a peak-fit, was used to determine if a peak-fit was reasonable or not. Based on practical experience a “chi-squared” value between 1 and 2 implies a relatively good peak-fit. A “chi-squared” value between 2 and 4 implies that the fit has not yet been optimized. A “chi-squared” value larger than four (4) implies that one or more signals are missing from the peak-fit.

A Shirley-type (sigmoid) baseline was used for most peak-fits. Peak-fits for the main XPS signals were optimized by using a Gaussian:Lorentzian ratio between 80:20 and 90:10. After peak-fitting many binary oxides, we observed that the FWHM of the C(1s), O(1s) and the main metal signal of the binary oxide were usually in range 1.0-1.4 eV. We used this observation as an indicator of charge compensation quality. If one of the peaks fell with this range (1.0-1.4 eV), then all other spectra were expected to represent spectra without charge induced broadening. If all three of the main spectra were found to have FWHM > 1.5 eV, then we understood that charge compensation was not adequate. In response, we repeated some measurements until at least one of the main signals had FWHM < 1.5 eV, by moving the mesh-screen closer to the surface of the sample or by increasing the flood gun voltage by 1-3 eV.

Charge Compensation of Non-Conductive Compounds

Charge compensation of non-conductive materials was handled by using the patented SSI mesh-screen together with a low voltage flood gun of electrons which used an acceleration voltage adjusted to 2-4 eV, unless otherwise noted. The mesh-screen device uses an 85% transmission electro-

formed mesh made of nickel metal that is supported above the surface of the sample by mounting the mesh on a conductive metal frame that is grounded to the sample mount. To achieve good charge compensation the mesh-screen was positioned so the distance between the mesh and the surface of the sample is between 0.5-1.0 mm. When the distance between the mesh-screen and the surface of the sample is greater than 1.2 mm, the usefulness of the mesh-screen flood gun system was null. This mesh-screen method has been found to useful on a wide variety of XPS systems that use monochromatic X-rays and a source of electrons that are from a flood source or a poorly focused source of low voltage electrons.

The mesh-screen is understood to function as an electron cut-off lens with some tendency to allow incoming flood gun electrons to focus on the area being irradiated with monochromatic X-ray beam because the X-ray beam does not have a uniform flux density of the area of the beam. In effect, the mesh-screen produces a nearly uniform electric potential at the surface of the sample and allows incoming flood-gun electrons to pass through whenever they are needed.

The mesh-screen was used above every sample except for a few that were analyzed before the mesh-screen method was invented. Because the electrical nature of many of the samples was unknown until we attempted to collect data, nearly all samples were covered by the mesh-screen device. When the mesh-screen covers a conductive sample there is a very slight drop in counts because the mesh-screen captured or deflected some of the photo-emitted electrons. If ion etching is done with the mesh in place, then a slight amount of nickel appears on the ion etched sample.

Abbreviations Used

Due to the limited space provided to describe each sample in each electronic data-file, it was necessary to use various abbreviations. The abbreviations are:

TOA = take-off-angle for the electrons (the angle between the surface plane and the main axis of the electron collection lens)
FG = flood gun
mesh = mesh-screen used for charge control
1mm = 1 mm height used for the mesh-screen
semi-con = semi-conductive behavior
Tech = technical grade purity
pellet = sample pressed into pellet form by pellet press used to make infrared KBr pellets,

INSTRUMENT AND ANALYSIS CONDITIONS USED TO COLLECT XPS SPECTRA

A. Instrument Details

Manufacturer:	Surface Science Instruments (SSI)
Model:	S-Probe (upgraded from M-Probe model 2703)
Operation Software:	1.36.05 (Compiled in MS-DOS "C" v6.0)
Analyzer Type:	Fixed Analyzer Transmission (FAT), which is the same as: Fixed Pass Energy = Constant Analyzer Energy (CAE) 180° Hemi-spherical (truncated)
Input Lens Field of View:	30° for sample normal to lens axis (1" diameter port) (always larger than X-ray beam; retarding potential scanned)
X-ray Type:	Al° K_α monochromatic (one 2" diameter, thin, natural SiO_2 wafer glued onto a Zerodur substrate and heated to 65° C)
X-ray Source:	10 kV, 1.5-22.0 mA (depending on spot size used)
X-ray Energy Defined as:	1486.7 eV (8.3393 Å), Bragg angle = 78.5°
Excitation Source Window:	0.6 µ aluminum in S-Probe (10µ Mylar in X-Probe)
Angle of X-ray Incidence:	α = 71° (relative to sample normal)
Electron Emission Angle:	β = 0° (relative to sample normal)
Angle between X-ray Axis and Electron Analyzer Axis:	ϕ = 71° (fixed, non-variable)
Pass Energies of Analyzer:	150 V for Resolution 4 setting 100 V for Resolution 3 setting 50 V for Resolution 2 setting 25 V for Resolution 1 setting
Type & Size of Input Slit:	Fixed (2 mm X 35 mm) with magnetic compression
Type & Size of Output Slit:	None (dispersion limited by hemisphere voltages)
Electron Collection Lens Field of View:	~ 1 mm^2 for β = 0° at 1,000 eV KE
Electron Collection Lens Efficiency:	7% over 2π steradians
Sample Surface to Tip of Electron Collection Lens Distance:	~33 mm
Crystal to Sample Surface Distance:	~190 mm

Crystal to X-ray Anode Distance:	~190 mm
True Background Noise:	<10 electrons/second at -50 eV (shot noise limited)
Detector Type:	SSI Position Sensitive Detector, resistive anode encoder, 40 mm X 40 mm, electronically defined as 128 active channels with max ct rate of 1,000,000 cps
Dead Time:	zero (unless ion etching pure element while collecting data)
Base Pressure:	4×10^{-10} torr
Normal Operating Pressure:	1.6×10^{-9} torr
X-ray FWHM Diffracted by natural SiO_2:	~0.25 eV
Power Settings:	200 Watts in a 250 x1100µ X-ray beam 100 Watts in a 150 x 800µ X-ray beam 45 Watts in an 80 x 350µ X-ray beam 15 Watts in a 40 x 250µ X-ray Beam
X-ray Induced Current:	1.1×10^{-9} amps for a 600µ spot in X-Probe
Approximate True X-ray Power:	$\sim 6 \times 10^{-6}$ W in a 600µ spot
Approximate True X-ray Irradiance:	~8 W/m^2
Approximate True X-ray Photon Flux:	$\sim 7 \times 10^{9}$ photons/sec

B. Experimental Details

Electron Take-Off-Angle:	90° relative to sample surface (unless otherwise reported)
Pass Energies Used:	Wide scans were done at PE = 150 eV Narrow scans were normally done at PE = 50 eV Valence band scans were done at PE=150 eV
X-ray Beam Size Used: (S-Probe system)	Wide scans: 250 x 1500 µ ellipse (at 90° TOA) 250 x 1100 µ ellipse (at 35° TOA) Narrow Scans: 250 x 1500 µ ellipse (at 90° TOA) 150 x 1000 µ ellipse (at 90° TOA)
SSI Mesh-Screen:	An 85% transmission (20 µ diameter wire with 200 µ spacing) nickel metal mesh screen was adhered to a small 25 mm x 25 mm x 1.5 mm (W x L x H) aluminum plate with a 20 mm x 20 mm aperture. The mesh-screen was placed over all insulating samples

	So that the distance between the sample surface and the mesh-screen was <1.0 mm but >0.5 mm.
Dwell Time (counting time):	200 milliseconds/channel
Data Transfer Time:	4 milliseconds
Max. Number of Channels:	5,000 (channels = data points)
Scan Time for One Wide Scan:	~ 3.5 minutes (using 1024 data points)
Scan Time for One Narrow Scan:	~100 seconds (using 256 data points)
Energy Range:	-100 to +1400 eV (BE range)
Typical Step Size:	0.1 eV/step (i.e. 0.1 eV/data point)

C. Data Processing Details

Baseline Subtraction:	None, unless S/BG gave a small display. When the baseline was removed, the intensity of the lowest point was subtracted from all points.
Data Smoothing:	None (the 128 channel PSD system producing a smoothing effect)
Energy Shifting:	All non-conductive samples were charge referenced so that the hydrocarbon carbon (1s) signal appeared at 285.0 eV.

D. Sample Details

The "Description" given on the first page of each data set reports: the empirical chemical formula for the oxide, the hydroxide or carbonate, the reported bulk purity, source, a production lot number, the electron take-off-angle (TOA), the height of mesh-screen above the surface, the electrical behavior of the sample under analysis conditions, sample color, sample preparation, sample size, known melting point in degrees Centigrade, density in grams/cubic-centimeters, and a note on solubility.

Sources of Commercially Pure Binary Oxide, Carbonate and Hydroxide Samples

Most of the commercially pure binary oxides were purchased from the Aldrich Chemical Co. Most of the packages from the Aldrich Chemical Co. included an "Analytical Information" sheet which reported an ICP or AA analysis summary, a production lot number, the Aldrich product number, sample purity (e.g. 99+%), sample appearance (color and physical form), date of chemical analysis, formula weight and a label on the bottle that reported the melting point, toxicity, a Chemical Abstracts registry number and density. The samples from Aldrich were generally quite pure. Other oxide samples were obtained from either Cerac Inc. (USA) or Rare Metallics Co., Ltd.

(Japan). These samples tended to have mixed oxides. The packages from Cerac Inc. included a "Certificate of Analysis" with an ICP or AA analysis summary, a production lot number, a product number, purity (e.g. 99+%), and mesh size. The packages from Rare Metallics Co. did not include analytical data reports, but instead had stock numbers and a purity statement. Two samples (i.e. SiO_2 natural crystal and Al_2O_3 as a fused plate) were obtained from in-house sources and do not have any purity reports.

Powdered Samples - Pressed into 3 mm Diameter Pellets

Until analyzed, all finely powdered samples were kept un-opened, in their original glass or plastic containers, which were packaged inside of plastic-lined aluminum bags and stored in an electrically controlled dehumidifier. Just prior to analysis, each bottle was opened in the normal air of the room, where the XPS system was kept, and a small 50-100 mg portion of the powdered sample was removed via a clean Nichrome spatula and placed in the compression chamber of a hand-operated, stainless steel pellet press (Qwik Handi-Press) that is normally used to produce pellets for infrared analyses. All finely powdered samples were compressed without any treatments. The resulting pellets varied in thickness from 0.3 - 0.8 mm. The "Qwik Handi-Press" was manufactured by the Barnes Analytical Division of Spectra-Tech Inc. (652 Glenbrook Road, Stamford, Connecticut, 06906, FAX# 1-203-357-0609). Part # 0016-111 to 0016-121 contains 1, 3, and 7 mm die sets. Our hand-press was purchased through the Aldrich Chemical Co.

To avoid iron and/or chromium contamination from the anvil, a small piece of freshly cleaned aluminum foil was placed over the sample in the compression chamber. This aluminum foil is standard kitchen grade foil which was gently rubbed with a cotton swap lightly soaked with iso-propanol (IPA) and allowed to dry in air. Those powders, that were clumped together, were very gently ground into a powder just prior to compression. To avoid unnecessary heat-induced oxidation, those samples which were hard and granular were very gently and slowly hand ground into a fine powder using an agate marble mortar and pestle. As soon as each sample was removed from the compression chamber, it was mounted on top of a fresh drop of silver (Ag°) paint placed in the center of a 5 mm diameter brass boat that was 1.3 mm in height. Silver paint was used so that conductive oxides could behave as true conductors thereby providing true electron binding energies for those oxides that were indeed conductive. This arrangement kept the mesh-screen at a suitable distance from the sample surface. In general, each oxide was exposed to room air for <15 min.

Benefits of Pressing Powders into Pellets

A comparison of the electron counts obtained from powdered samples pressed onto double-sided adhesive tape and positioned at a 35° electron take-off-angle with the electron counts obtained from hand-pressed glossy or semi-glossy pellets positioned at a 90° electron take-off-angle (TOA) revealed that the pellet form at a 90° electron TOA produces 3-5 times higher electron counts than a powdered sample pressed onto double-sided tape at a 35° electron TOA. By pressing the finely powdered oxides into pellets, it was also found the surface charging behavior of these glossy or semi-glossy samples was very easy to control with the mesh-screen flood-gun device.

Problems Caused by Pressing Powdered Samples into Pellets

By pressing finely powdered oxides into pellets, the surface of the resulting pellets were usually smooth enough to appear glossy or semi-glossy. A few samples were found to be contaminated with iron or chromium which indicated that the oxide had undergone a pressure induced reaction with the stainless steel anvil. Very strong hand pressure was indeed found to cause some oxides to react with the stainless steel anvil, but medium hand pressure did not produce the undesired iron and chromium contamination. Other forms of accidental contamination (chlorine or previously analyzed oxides) were caused by insufficient cleaning of the stainless steel anvil, which was normally cleaned with a chlorine-containing metal polishing solution (Pikal) and rinsed with distilled water and isopropanol. All analyses that showed any unexpected contamination were repeated.

Solution to Pressure Induced Contamination of Pellets

Extensive experiments on different methods to avoid contamination while producing pellets revealed that contamination is minimized or avoided by using freshly cleaned aluminum foil as a "buffer" between the oxide powders and the metals in the steel anvil components. The aluminum foil, which is sold as a kitchen wrap material, is cleaned with 100% isopropanol (isopropyl alcohol) just prior to use. The foil is cut to a size that is readily fits inside the pellet press device.

We have also used "glycine" weighing paper which is commonly used as a paper to hold powders when weighing them. This weighing paper is common in chemical laboratories and can be substituted for the aluminum foil whenever the pressing results with the aluminum foil produce undesired binding of the foil to the sample. The glycine paper method sometimes introduces very small amounts of contaminants which produce very weak N (1s) and C (1s) signals.

E. Energy Resolution Details

Table 1: Experimentally Observed Relation between Energy Resolution and Analysis Conditions

Signal and Material used to Define Effective Energy Resolution (treatment)	Energy Resolution FWHM (eV)	Pass Energy	X-ray Spot Size
Si ($2p_{3/2}$) (fractured edge of crystal)	0.38 eV	10 eV	40 x 250μ
Si ($2p_{3/2}$) (fractured edge of crystal)	0.43 eV	25 eV	80 x 350μ
Au ($4f_{7/2}$) (foil - ion etched clean)	0.64 eV	10 eV	250 x 1000μ
Au ($4f_{7/2}$) (foil - ion etched clean)	0.79 eV	25 eV	250 x 1000μ
Au ($4f_{7/2}$) (foil - ion etched clean)	0.86 eV	50 eV	250 x 1000μ
Au ($4f_{7/2}$) (foil - ion etched clean)	1.40 eV	150 eV	250 x 1000μ
Ag ($3d_{5/2}$) (foil - ion etched clean)	0.42 eV	10 eV	40 x 250μ
Ag ($3d_{5/2}$) (foil - ion etched clean)	0.64 eV	25 eV	40 x 250μ
Ag ($3d_{5/2}$) (foil - ion etched clean)	0.75 eV	50 eV	40 x 250μ
Ag ($3d_{5/2}$) (foil - ion etched clean)	1.00 eV	100 eV	40 x 250μ
Ag ($3d_{5/2}$) (foil - ion etched clean)	1.30 eV	150 eV	40 x 250μ
Cu ($2p_{3/2}$) (foil - ion etched clean)	0.85 eV	10 eV	250 x 1000μ
Cu ($2p_{3/2}$) (foil - ion etched clean)	0.94 eV	25 eV	250 x 1000μ
Cu ($2p_{3/2}$) (foil - ion etched clean)	1.06 eV	50 eV	250 x 1000μ
Cu ($2p_{3/2}$) (foil - ion etched clean)	1.60 eV	150 eV	250 x 1000μ
Cu ($2p_{3/2}$) (foil - ion etched clean)	0.85 eV	10 eV	150 x 800μ
Cu ($2p_{3/2}$) (foil - ion etched clean)	0.96 eV	25 eV	150 x 800μ
Cu ($2p_{3/2}$) (foil - ion etched clean)	1.05 eV	50 eV	150 x 800μ
Cu (3s) (foil - ion etched clean)	2.35 eV	50 eV	250 x 1000μ

Table 2: Theoretical Analyzer Resolution versus Pass Energy Setting

Theoretical Analyzer Resolution	Pass Energy	Effective Detector Width
0.25 eV	25 eV	3.5 eV
0.50	50	7.0
1.00	100	14.0
1.50	150	21.0

F. Energy Scale Reference Energies and Calibration Details

From May 1986 to January 1993 (Based on HP energy calibration)

Energy Scale Reference Energies:	932.47 eV for Cu ($2p_{3/2}$) signal
	122.39 eV for Cu (3s) signal
	83.96 eV for Au ($4f_{7/2}$) signal
Binding Energy Uncertainty:	< ±0.08 eV
Digital-to-Analog (DAC) Conversion Setting:	163.88

After January 1993 (Based on NPL reference energies published in 1990)

Energy Scale Reference Energies:	932.67 eV for Cu ($2p_{3/2}$) signal
	122.45 eV for Cu (3s) signal
	83.98 eV for Au ($4f_{7/2}$) signal
Observed Reference Energy:	75.01 eV for Cu (3p3) signal
Binding Energy Uncertainty:	< ±0.05 eV
Digital-to-Analog (DAC) Conversion Setting:	163.87

Note: NPL has recently revised reference energies to be 932.62 eV for Cu ($2p_{3/2}$) and 83.96 eV for Au ($4f_7/2$) for monochromatic systems using an electron take-off-angle of 45^o (Ref. 8)

Reference Energies for Adventitious Hydrocarbon Contaminants

From May 1986 to January 1993 the electron binding energy of adventitious hydrocarbons was assumed to occur at 284.6 eV based on SSI and C. D. Wagner's research and recommendations.

Publications by P. Swift in the journal of Surface and Interface Analysis **4**, p.47 (1982), S. Kohiki and K. Oki in the Journal of Electron Spectroscopy and Related Phenomena **33**, p.375-380 (1984), and G. Barth, R. Linder and C. E. Bryson, III in the journal of Surface and Interface Analysis **11**, p.307-311 (1988) have shown that the electron binding energy for various hydrocarbon contaminants and polymers is not necessarily a constant number.

Research by this author indicates that the electron binding energy for adventitious hydrocarbons lies somewhere between 284.4 and 287.0 eV and is dependent on the electronic nature of the surface. By taking a simple average of all available binding energies, the author has found that 284.9 eV is average binding energy for hydrocarbons captured from UHV onto the surface of recently ion etched metals where the surface is many hours old (>8 hr). For naturally-formed native oxides, the average binding energy is 285.2 eV. Binary oxides, for metals located at the far left of the periodic table (columns 1-4) tend to have higher C (1s) binding energies (285.3-286.7 eV), while most of the transition metal oxides center around 285.0 eV. Near the far right of the periodic table, the C (1s) binding energy rises to a 285.2-286.5 eV range (columns 12-14).

In routine practice, this author prefers to use the 285.0 eV number to compare data with previous publications. Factors that may cause this rather large range of electron binding energies for adventitious hydrocarbon contamination include: (a) variations in surface dipole moment at the vacuum-surface interface of the oxide material, which is known to be much larger in length and intensity than the surface dipole moment of a pure metal, and also, in the case of naturally formed native oxide films, (b) the thickness of the native oxide, (c) any physical or chemical treatments, (d) the thickness of the adventitious hydrocarbon layer, and (e) the electrical behavior of the instrument used to analyze the sample. The type of instrument being used may cause different shifts in the observed binding energy of the adventitious hydrocarbon contamination because the source may or may not generate different amounts of low energy secondary electrons from the window that protects the X-ray source. The heat from the source and contamination that de-gases from a just turned on source can also influence observed binding energies. Electron flood guns may or may not influence the binding energy as well.

Instrument Stability and Long Term Calibration

Each of the three SSI XPS systems, that we have used, was calibrated 2-3 times per week until its ability to maintain accurate voltage settings was defined. Once it was determined that the systems could maintain reliable voltage settings for 1-3 months, it was decided that good calibration could be maintained by checking and, if necessary, correcting the pass energies of the system on a 2-4 week basis. Each of the three SSI XPS instruments that we have used, have been checked or calibrated on a routine basis every 2-4 weeks by using SSI's

reference energies. By using this method over several years time, it was found that the maximum uncertainty (error in pass energies) was normally < ±0.10 eV, but a few times rose to ±0.15 eV or less. In a very rare case, the uncertainty rose to 0.20 eV. Long term use of the SSI systems has shown that the DAC circuit does not change enough to be observed unless the room temperature changes by more than 10 degrees Centigrade. If the room temperature changes within a few hours time by more than 10 degrees or the temperature of the DAC chip is changed by more than 10 degrees, then a >0.1 eV shift, which is much, much smaller than the reliability of almost all literature data, can be observed. Variables, which seem to cause pass energy settings to change slightly, include building line-voltages, ion etching conditions, and the addition or removal of some electrical device.

G. Electron Counting and Instrument Response Function Details

Instrument Response Functions (for the X-Probe System only)

Instrument Response Function: $Q(E) = E^{+0.27}$ for 150 eV PE (ref.3)
Instrument Response Function: $Q(E) = E^{+1.0}$ for 50 eV PE (ref.3)

Signal/Background Ratios for Ion Etched Silver using a 250x1000 µ Spot*

Pass Energy	25 eV	50 eV	100 eV	150 eV
S/BG ratio**	>140	>110	>70	>50

* Using a 90° electron take-off-angle and a smooth Ag°/Mylar film.
** The S/BG ratio is a simple numerical ratio of electrons counts at the peak maximum relative to the average electron counts observed at approximately 10 eV lower BE.

Voltage Settings of the Electron Collection Lens

Pass Energy*	29.6-29.8	54.7-54.9	105.1-105.3	155.9-156.2
Detector Widths	3.743	7.486	14.954	22.297
Sensitivity Exponent	-0.1	0.3	0.7	1.1
V1 Offset	30	55	105	155
V1 Slope	0.600	0.611	0.676	0.709

*These pass energies include corrections for instrument work function. True pass energies were set to 25, 50, 100, and 150 eV ±0.1 eV.

H. Effects of Poorly Focusing the Distance between the Sample and the Electron Lens

If the focus distance between the sample surface and the electron collection lens is poorly adjusted, then the number of electron counts drops very quickly. A 0.5 mm error in focus produces a >300% decrease in counts, but does not produce any observable error in binding energies. A 0.1mm error in focus produces a 15% decrease in peak area counts and is easily observed as a horizontal displacement in the static (un-scanned mode) XPS signal as observed on the standard CRT display of the detector signal. Such a decrease in signal intensity causes the operator to correct the focus error to maximize the electron count rate and maintain good laboratory practice and self-consistency. In this manner, the operator minimized the chance of obtaining false BE readings and has accurately reproduced a nearly absolute focus point which greatly increases the quantitative accuracy of any unknown sample and the accuracy of the measured binding energies. Experiments with Bragg angle alignment of the crystal indicated that the maximum error due to an unusual bad alignment of the crystal would be <0.1 eV. To observe an error greater than 0.1 eV, the electron counts were found to decrease by >50%.

I. Quantization Details and "RSF Exponents"

By default, the SSI system uses a 0.7 number as the RSF exponent factor for each pass energy setting which is used in an equation that modifies theoretically calculated atomic photo-ionization cross-sections (John H. Scofield) to generate relative sensitivity factors that are valid for this XPS systems and which can be used to generate valid atomic percentages. This correction corrects for the overall instrument response function which includes the transmission function. For signals in the 0-700 eV range, the 0.7 RSF exponent factors produces a ±10% accuracy in quantitative results for XPS signals obtained with 150 eV pass energy. For signals that occur at higher binding energies, it is necessary to change the RSF exponent factor to a 1.1-1.5 value.

To obtain a useful RSF exponent factor for an SSI system, it is possible to use freshly ion etched poly-crystalline copper foil to test the validity of the sensitivity exponent factor for larger BE ranges and different pass energies. By integrating the peak areas of the Cu($2p_{1/2}$), Cu($2p_{3/2}$), Cu(3s), Cu(3p) and Cu(3d) signals it is possible to perform trial and error choices of the RSF exponent until a useful number is determined. When a useful number is entered into the software routine, the software generates fictional atomic percentages for each of the integrated copper signals which, when optimized, generates a 20 atom % value with an uncertainty of ±1-2 atom % for all five signals. If the RSF exponent factor is wrong then the atomic percentages will generate numbers such as 10%, 11%, 26%, 24%, and 29% or perhaps 31%, 28%, 14%, 13%, and 14%.

This trial-and-error approach may require 1-2 hours time and can be done by using wide scan survey spectra data or more preferably narrow scan spectra for each of the pass energies. This method, in effect, assumes that all five of the relative sensitivity factors (RSFs) for copper are reasonably correct which was confirmed by analyzing various natural crystals and pure polymers.

This method, in effect, assumes that the pure copper sample is a standard material that is composed of 5 components which are present in 20 atomic % abundances. Once a useful RSF exponent factor is found it will generate a 20 atom % result for each of the five copper signals. After a useful RSF exponent factor is found, it is tested by analyzing freshly exposed bulk regions of crystalline materials such as SiO_2, Al_2O_3, and NaCl. The high and low BE signals of the NaCl crystal are especially useful to test the validity of the sensitivity exponents.

As further checks, the freshly exposed bulk of common polymers (e.g. Mylar or PMMA) or a thin film of high purity silicone oil can also be analyzed. Teflon has repeatedly given slightly larger than desirable error by comparison to the other materials listed above. For that reason Teflon is a less desirable material to test the sensitivity exponents.

J. Test of the Reliability of Relative Sensitivity Factors (RSFs)

Crude testing of Scofield's RSF numbers was performed by measuring the atomic percentage of each signal for a pure element. This testing used the software's automatic peak area integration software that is reasonably accurate. The results indicate that some of the relative sensitivity factors for some of the weaker signals may be more uncertain. If, however, all factors are taken into account, then Scofield's numbers are reliable to a 90-95% accuracy level for truly homogeneous materials.

K. Traceability Details

The definition of traceability reported by Martin P. Seah and Cedric J. Powell in the J. Vac. Soc. Technol. Vol 8, p.736 (1990) publication is: "The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons."

Traceability of Reference Binding Energies (Calibration)

At the time that these spectra were collected, there were no international standards for binding energies or reference energies. Recently, many people in the world have been using NPL's reference energies, which have become "de facto" standards. After further refinement and round-robin testing, the NPL values have become ISO values.

Many workers and researchers are unfortunately still using various numbers provided by the instrument makers. The author of this book was using Surface Science Instruments (SSI) Co. reference energies until December 1992, and then switched to NPL binding energies (binding energies (BEs)) in January 1993. SSI reference energies originally came from Hewlett-Packard (HP) and their high precision voltage systems. SSI and HP both used high precision voltage meters from HP to calibrate their ESCA machines (i.e. X, M, and S-Probe and HP-5950 A-type and B-type, resp.).

In a recent effort to improve the accuracy of binding energies (BEs) obtained from pure elements, the S-Probe pass energies were checked and corrected, if needed, almost every work-day for two months to obtain high precision and high accuracy binding energies (BEs) for the pure elements that are metals. This study used the NPL reference energies with Cu ($2p_{3/2}$) at 932.67 eV with +/- 0.02 uncertainty and Au ($4f_{7/2}$) 83.98 eV with +/-0.02 uncertainty by using 0.02 eV/pt. steps for the calibrations. To determine the "true" BE of each of the pure elements, which were scraped clean in air and then ion etched in vacuum, a 0.05 eV/pt. step-size was used. A repetitive ion etching (depth profile) style was used to collect wide scan, valence (Fermi edge) band, and narrow scans of the main signals for each metal at 50, 25 and 10 eV pass energies. Each repetitive experiment run lasted about 4 hours. If NPL BE numbers are accepted as "de facto" international standards, then the ultimate traceability of binding energies (BEs) in this data set can be related to NPL BE numbers for Cu ($2p_{3/2}$) and Au ($4f_{7})_{/2}$. Because the refined NPL values are now ISO standard values, the traceability of the reference energies used in this data set are traceable to ISO standards.

Transfer of Traceability from Pure Metals to Non-conductive Binary Oxides

A question that should be posed is traceability to the non-conductive binary oxide binding energies. For the binary oxides in this volume, traceability begins with NPL's binding energies (BEs) for pure copper and gold as state above. Traceability then transfers to pure element binding energies (BEs) which is based on NPL reference binding energies (BEs). Traceability then transfers to pure element binding energies (BEs) based on SSI's reference binding energies (BEs), and then the naturally formed native oxide data published in Volume 1 of our XPS Handbook series where binding energies (BEs) were measured from pure element signals and also the naturally formed native oxide signals.

Naturally formed native oxides typically have thin oxide films (10-80Å) which, in general, behave as good or true electrical conductors, which allows a direct measure of the true binding energy of many, but not all, binary oxides. To determine if traceability can indeed be transferred to true binary oxides, it was necessary to study the behavior of the naturally formed native oxides by applying various flood gun settings with the samples grounded and insulated. The results from that study can be used to transfer traceability to the experimentally observed binding energies (binding energies (BEs)) of pure binary oxides. The most difficult transfer of traceability occurs for the naturally formed native oxide systems. If the flood gun study was not done, then it is difficult to transfer traceability in a reliable manner from a conductive metal to one of its corresponding non-conductive binary oxides.

Traceability of Instrument Response (Throughput) Function

Copper, gold and silver data obtained from the M-Probe system were submitted to Martin P. Seah at the NPL for a round robin test on transmission function; the results of which were published in the journal of Surface and Interface Analysis, p.243 (1993). In that publication, M-Probe data, which we contributed, were attributed to group #35. That paper reported that instrument has a $Q(E) = E^{0.27}$ for a Res 4 pass energy (PE=150eV) and a $Q(E) = E^{1.0}$ for the Res 2 pass energy (PE=50 V). If the NPL method is accepted as a "de-

facto" standard, even though it is not an internationally recognized standard, then the transmission function and quantitation results of the S-Probe system are traceable to the "metrology spectrometer" at NPL.

Traceability of Relative Sensitivity Factors (RSFs) used for Quantization

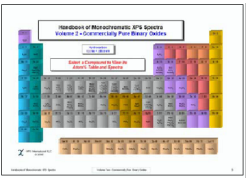
Scofield's theoretically calculated photo-ionization cross-sections are internationally used as the "de-facto" standard theoretical RSFs, except in Russia and a few other places, where other RSF numbers are preferred but are, in effect, after renormalization almost identical to Scofield's RSFs. The SSI system uses a very simple equation that modifies normalized values of Scofield's photo-ionization cross-section values to generate relative sensitivity factors. That equation corrects the instrument response function for differences due to pass energy, differences due to transmission function, and the inelastic mean free path versus kinetic energy dependency.

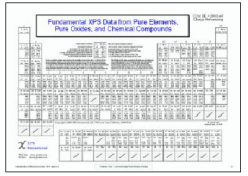
Traceability of Sample Purity

The purity of the commercially pure (99%) binary oxides is linked to the ICP or AA analyses performed by the Aldrich Chemical Co. and their methods for calibrating their instruments.

L. Reference Papers Describing Capabilities of X-Probe, M-Probe, and S-Probe XPS Systems

1. Robert L. Chaney, *Surface and Interface Analysis*, **10,** 36-47 (1987) [re: X-Probe]
2. Noel H. Turner, *Surface and Interface Analysis*, **18,** 47-51 (1992) [re: Quantization]
3. M. P. Seah, *Surface and Interface Analysis*, **20,** 243-266 (1993) [re: Response Function]
4. L.T. Weng et al, *Surface and Interface Analysis*, **20,** 179-192 (1993) [re: Response Function]
5. L.T. Weng et al, *Surface and Interface Analysis*, **20,** 193-205 (1993) [re: Response Function]
6. B. Vincent Crist, *Surface Science Spectra*, **1**, 292-296 (1993) [re: KBr spectra]
7. B. Vincent Crist, *Surface Science Spectra*, **1**, 376-380 (1993) [re: Ar/C spectra]
8. M. P. Seah, I.S. Gilmore, and G. Beamson, *Surface and Interface Analysis*, **26,** 642-649 (1998)





XPS Spectra of Commercially Pure Binary Oxides

and a few Common Carbonates and Hydroxides

Legend to Spectra Pages

The following pages explain the information contained on the pages of each data set.

AgO

Silver (II) Oxide (FW = 123.87)
Surface Composition Table

Description: AgO (99%) from Aldrich Lot# 00108JV, pressed into 3 mm pellet, analyzed at 90 deg TOA, conductive gray-black powder pressed into 5 mm pellet, mp >100 C dec., d. 7.44, sol. in ammonia (dec.)

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
Ag 4d	4.9	4.9	1.55	1.5	62,729	
Ag 4p	58.7	58.7	1.36	1.5	63,032	
Ag 4s	96.8	96.8	0.64	1.5	19,754	
C 1s	284.5	284.5	1.00	1.5	24,842	27.9%
Ag 3d	367.5	367.5	18.04	1.5	556,356	38.6%
Ag loss	398.8	398.8	1.80	1.5	59,988	
O 1s	530.8	530.8	2.93	1.5	61,714	33.4%
Ag 3p3	572.8	572.8	8.06	1.5	162,297	
Ag 3p1	603.1	603.1	4.03	1.5	78,803	
Ag 3s	718.5	718.5	2.93	1.5	32,609	
O Auger	974.6	974.6	0.00	1.5	14,615	
Ag Auger	1134.7	1134.7	0.00	1.1	19,283	
Ag Auger	1189.0	1189.0	0.00	1.1	4,809	
Ag Auger	1225.6	1225.6	0.00	1.1	3,524	

Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2

AgO

Silver (II) Oxide (FW = 123.87)

Sample Description: AgO (99%) from Aldrich lot# 00108JV (contaminated with Ag2O), conductive pressed into 3 mm pellet, analyzed at 90 deg TOA

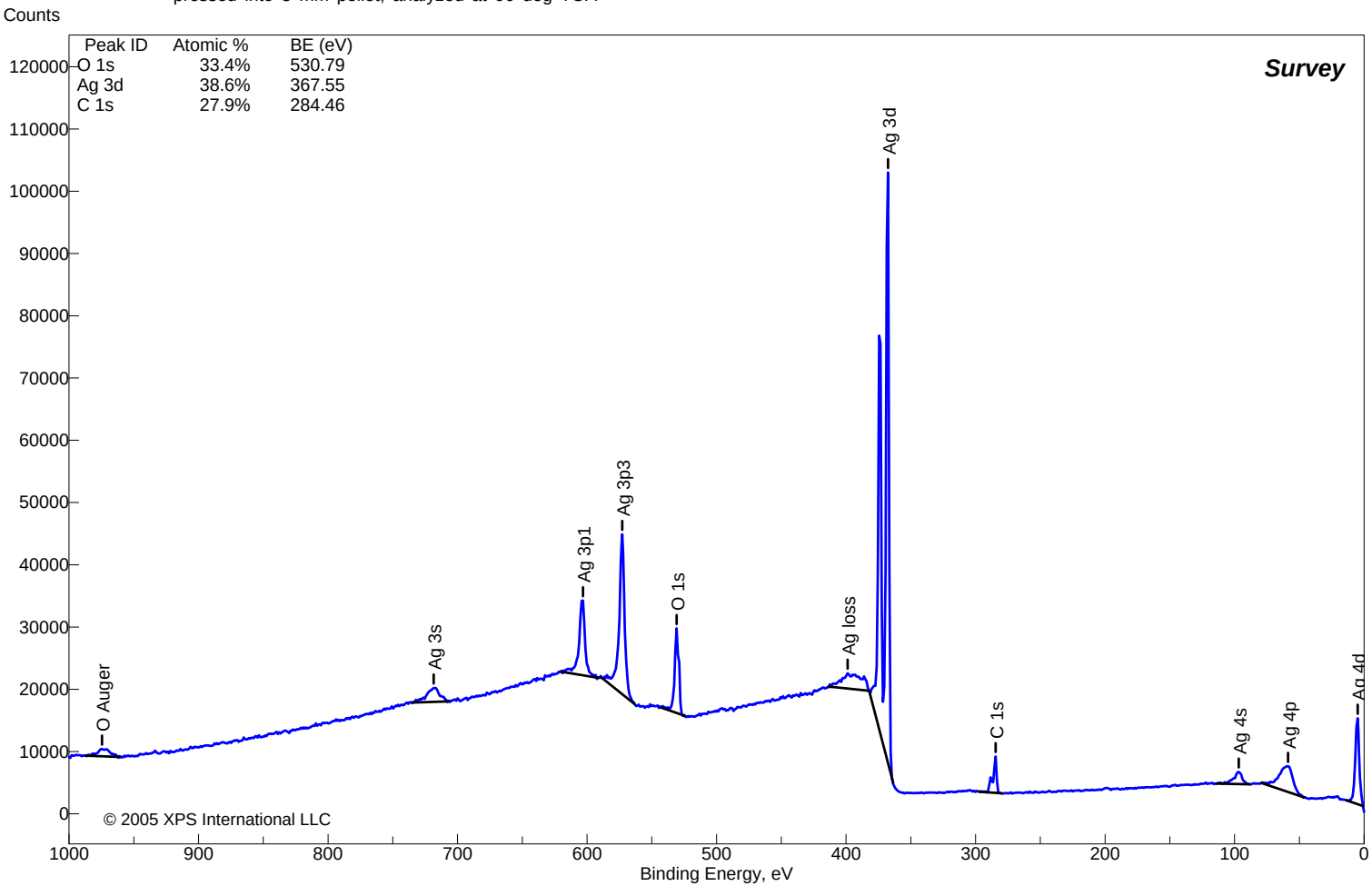


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2

AgO

Silver (II) Oxide (FW = 123.87)

Sample Description: AgO (99%) Aldrich lot# 00108JV (contaminated with Ag2O)
3 mm pellet, CONDUCTIVE, 90 DEG TOA

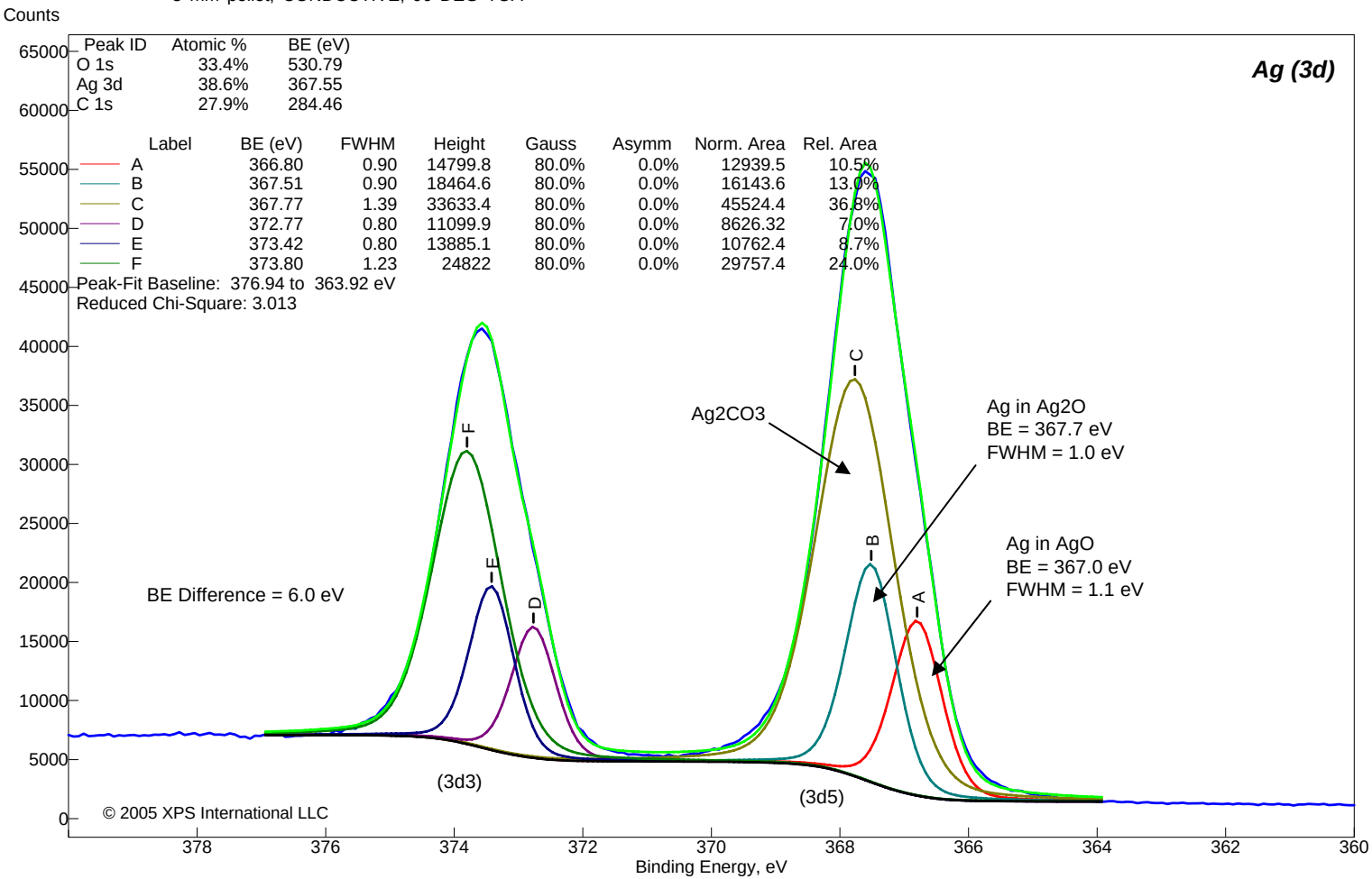


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2

AgO

Silver (II) Oxide (FW = 123.87)

Sample Description: AgO (99%) Aldrich lot# 00108JV (contaminated with Ag2O)
3 mm pellet, CONDUCTIVE, 90 DEG TOA

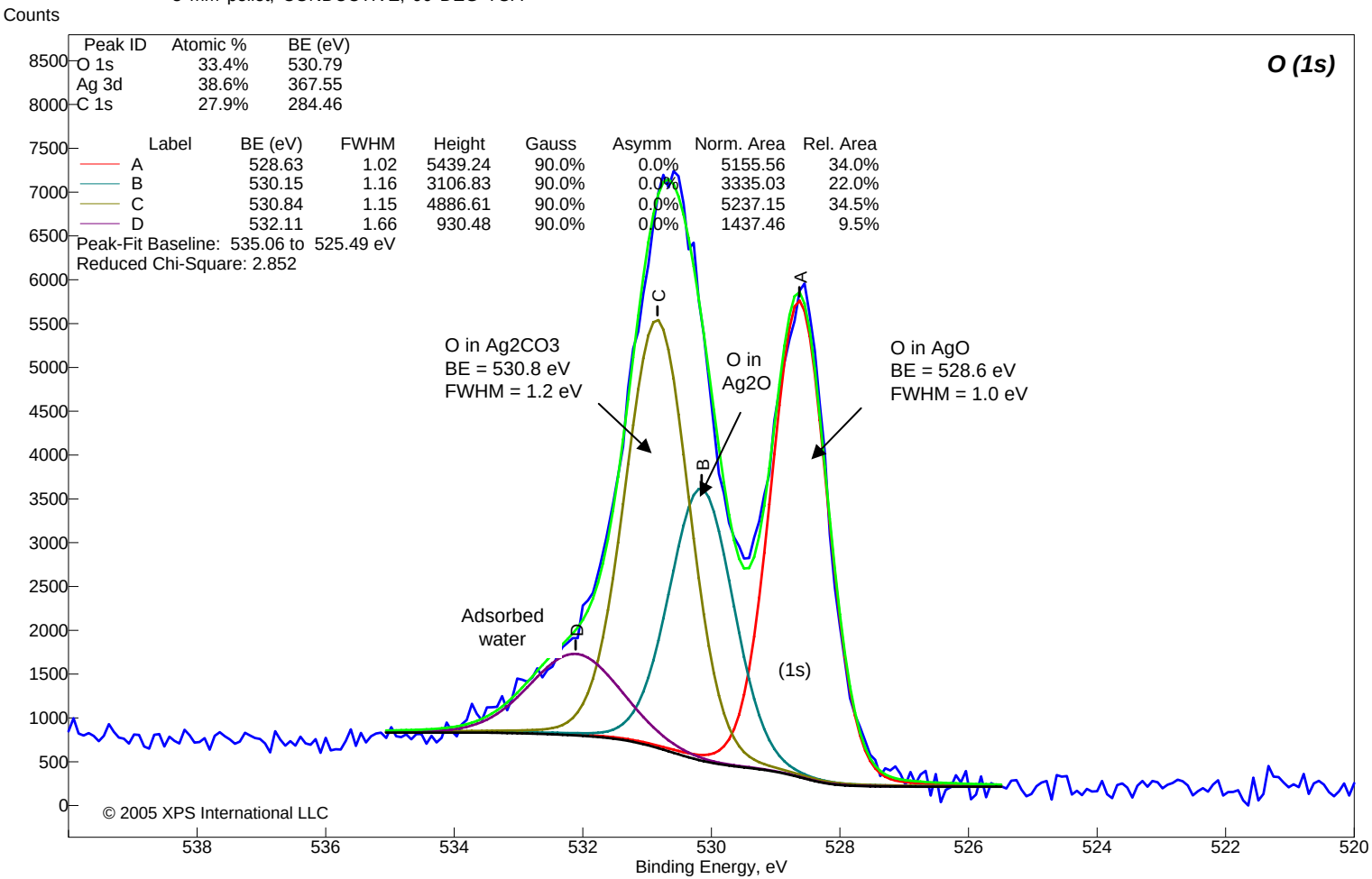


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2

AgO

Silver (II) Oxide (FW = 123.87)

Sample Description: AgO (99%) Aldrich lot# 00108JV (contaminated with Ag2O)
3 mm pellet, CONDUCTIVE, 90 DEG TOA

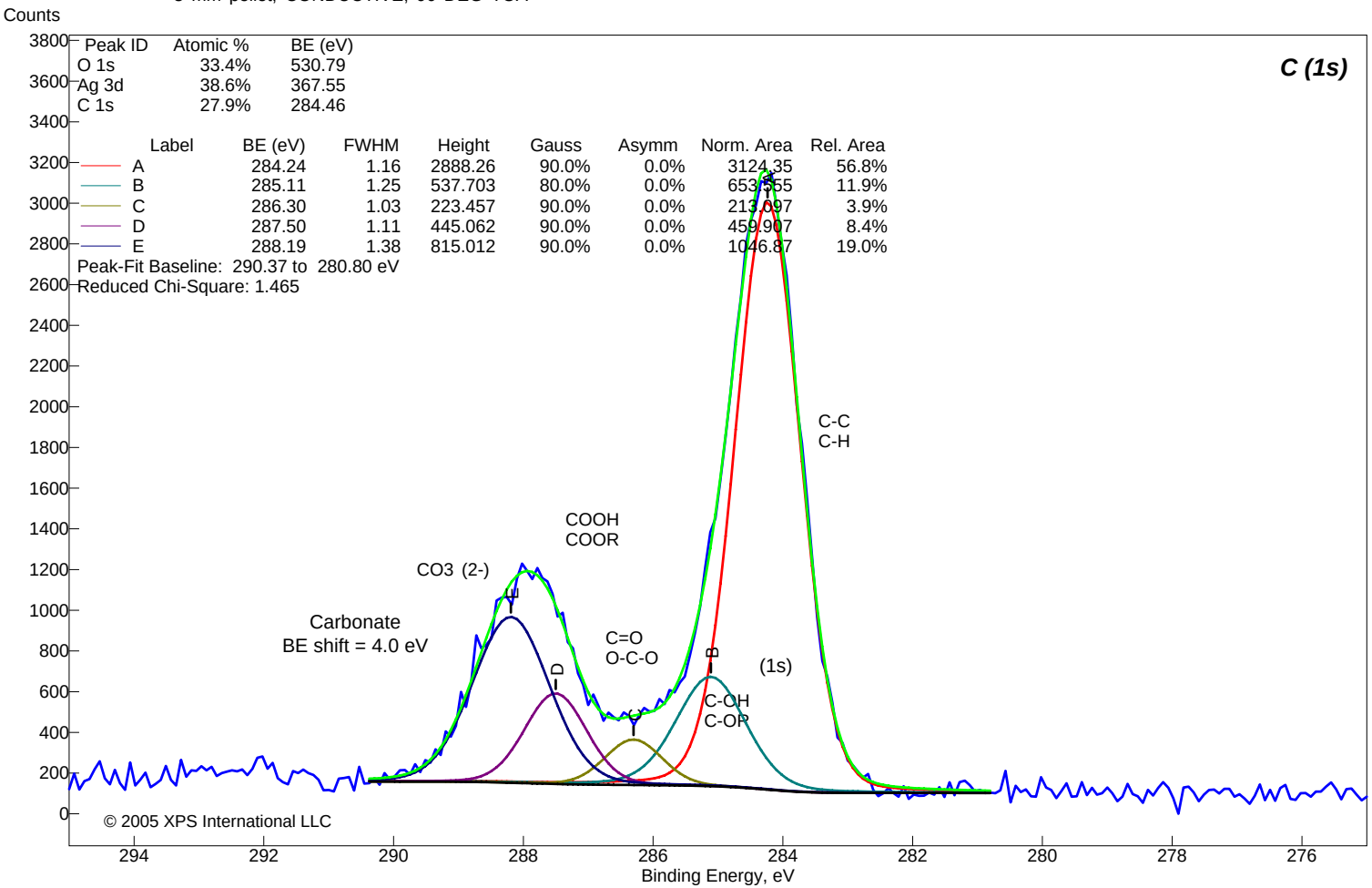


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2

AgO

Silver (II) Oxide (FW = 123.87)

Sample Description: AgO (99%) Aldrich lot# 00108JV (contaminated with Ag2O)
3 mm pellet, CONDUCTIVE, 90 DEG TOA

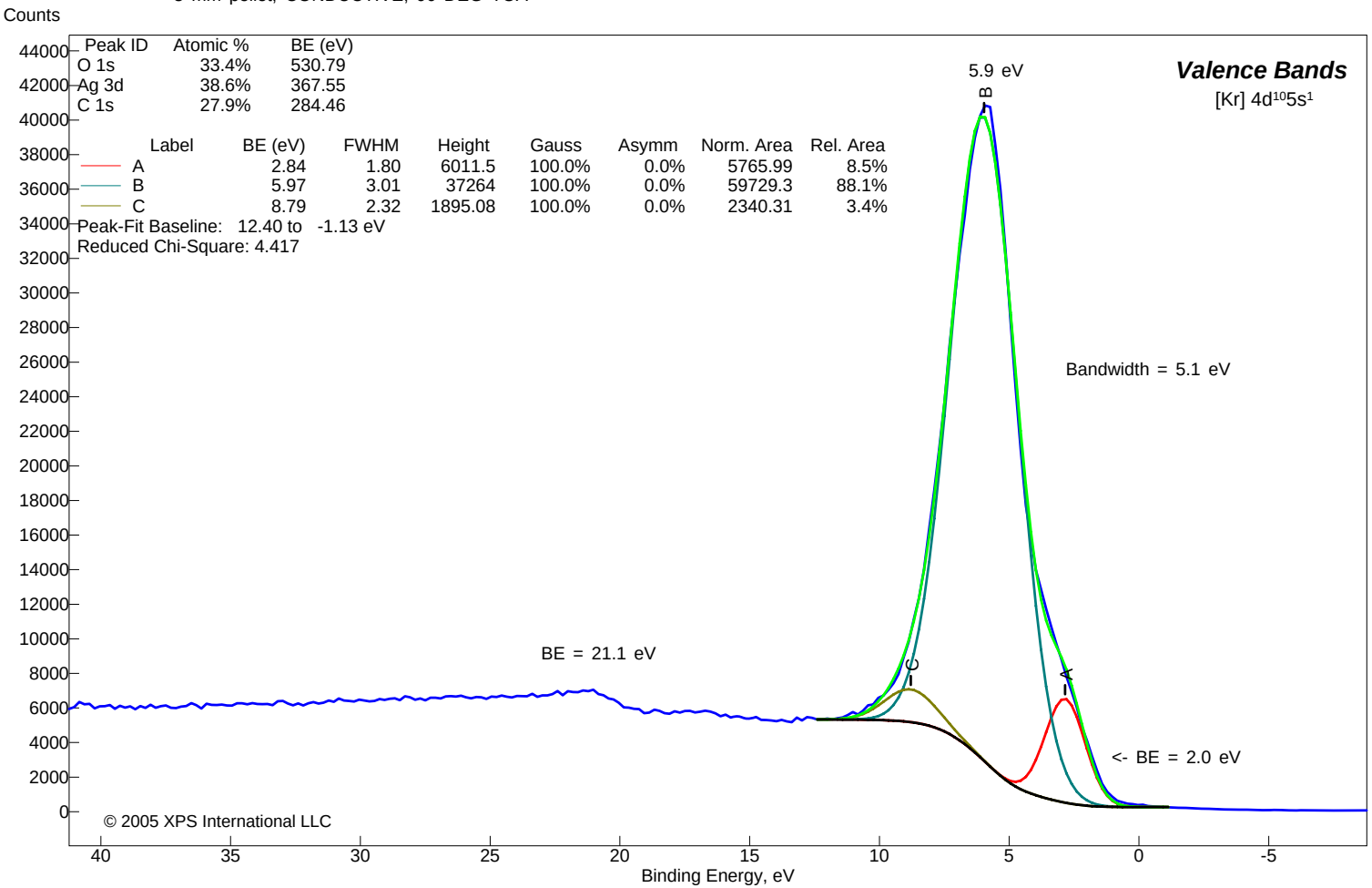
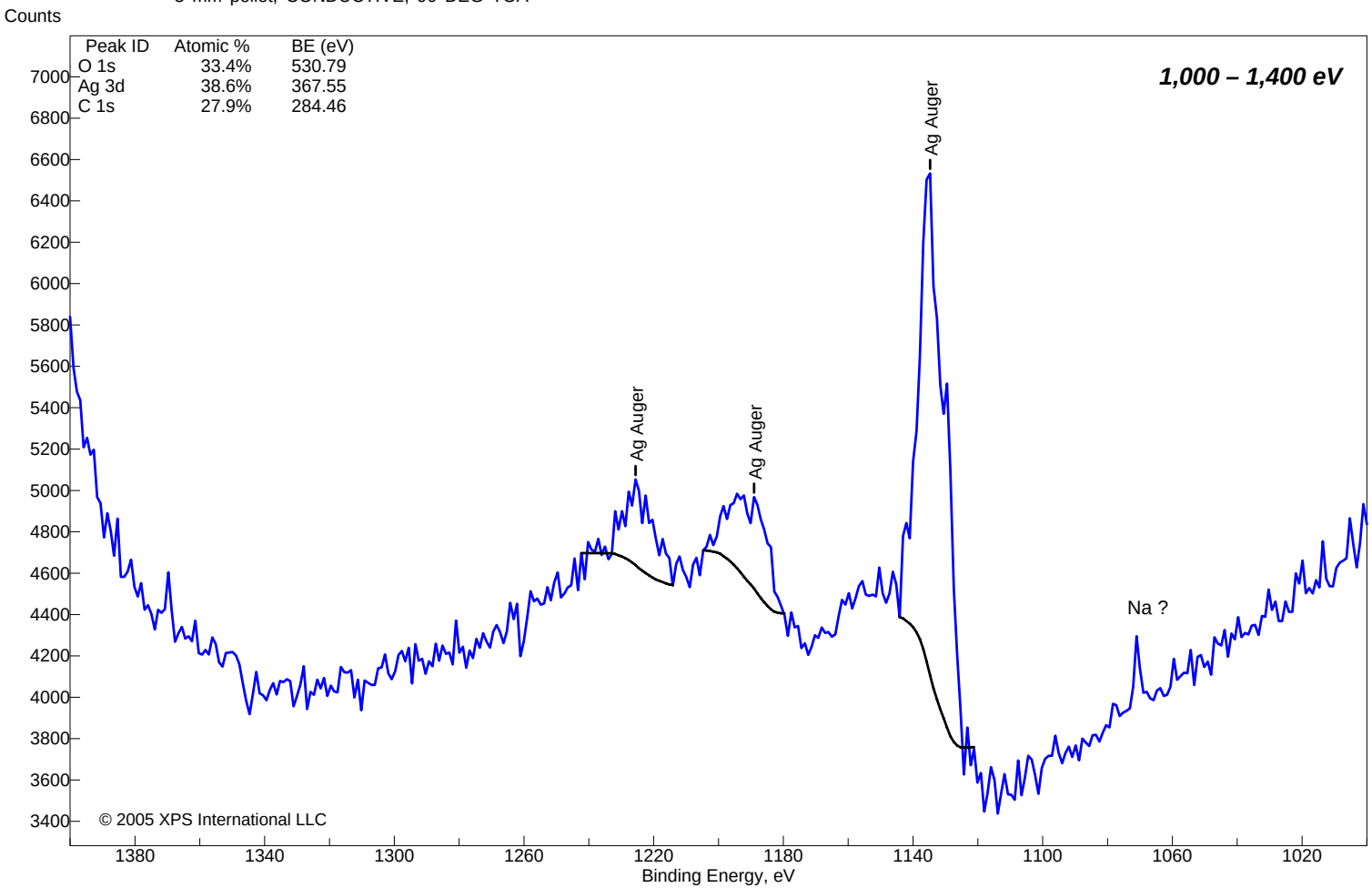


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2

AgO

Silver (II) Oxide (FW = 123.87)

Sample Description: AgO (99%) Aldrich lot# 00108JV (contaminated with Ag2O)
3 mm pellet, CONDUCTIVE, 90 DEG TOA



AgO

Silver (II) Oxide (FW = 123.87)

Sample Description: AgO (99%) Aldrich lot# 00108JV (contaminated with Ag2O)
3 mm pellet, CONDUCTIVE, 90 DEG TOA

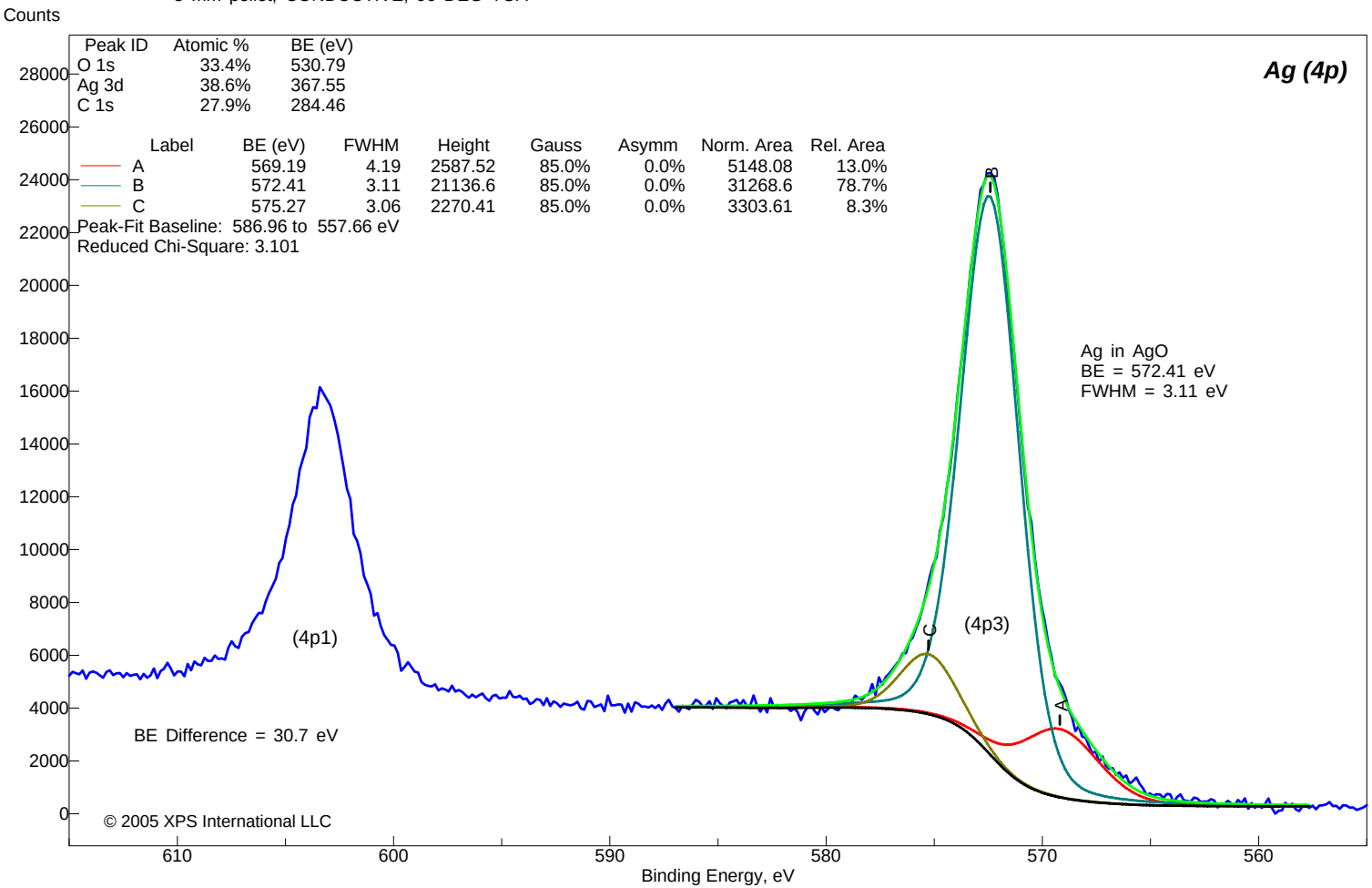


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2

Ag_2O

Silver (I) Oxide (FW = 231.74)
Surface Composition Table

Description: Ag_2O (99.99%) from Aldrich Lot# 00105CV, analyzed at 35 deg TOA, mesh at 1mm, conductive black powder pressed into 5 mm pellet, mp 230, d. 7.14, sol in dil. HNO_3 and ammonia

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
Ag 4d	5.6	5.0	1.55	1.4	5580.7	
Ag loss	26.1	25.5	0.15	1.4	2430.6	
Ag 4p	59.3	58.7	1.36	1.4	6388.2	
Ag 4s	97.5	96.9	0.64	1.4	2398.0	
S 2p	177.6	177.0	1.68	1.4	210.5	0.8%
C 1s	285.1	284.5	1.00	1.4	7338.6	52.6%
Ca 2p	340.9	340.3	5.07	1.4	337.9	0.5%
Ag 3d	368.2	367.6	18.00	1.4	51467.1	22.6%
Ag loss	391.7	391.1	0.00	1.4	11949.7	
O 1s	531.6	530.9	2.93	1.4	6937.9	23.4%
Ag 3p3	573.5	572.9	8.06	1.4	13040.6	
Ag 3p1	603.8	603.2	4.03	1.4	7758.5	
Ag 3s	719.2	718.6	2.93	1.4	1785.8	
O KLL-1	976.3	975.7	0.70	1.4	1379.4	

Table
Survey
M-1
O (1s)
C (1s)
VB

Ag_2O

Silver (I) Oxide (FW = 231.74)

Sample Description: Ag2O (99.99%) from Aldrich Lot# 00105CV
pressed into 5 mm pellet, analyzed at 35 deg TOA, mesh-screen at 1 mm height

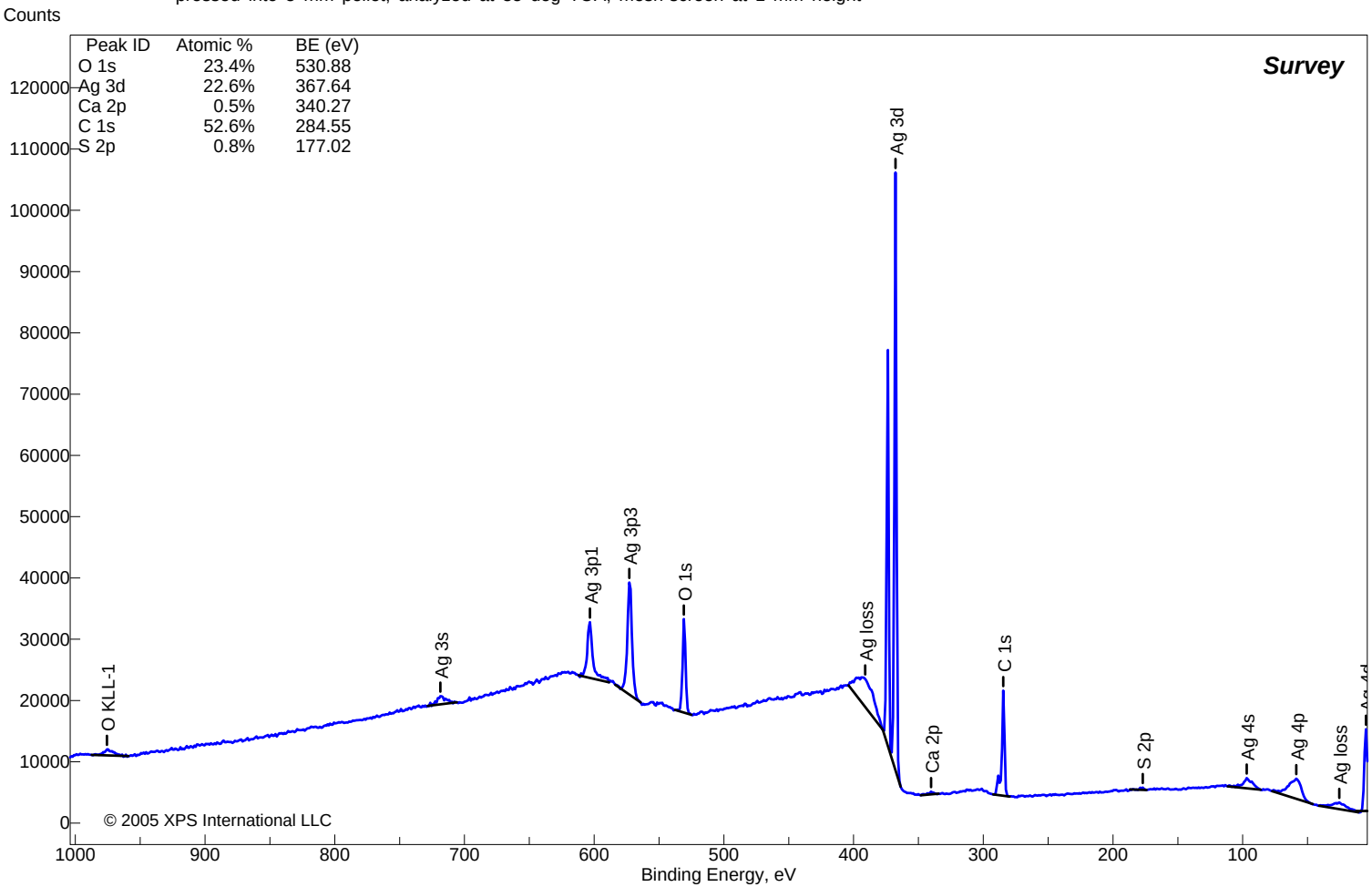


Table
Survey
M-1
O (1s)
C (1s)
VB

Silver (I) Oxide (FW = 231.74)

Sample Description: Ag2O 5mm pllt 99.99% Aldr Lot# 00105CV scrn 35TOA

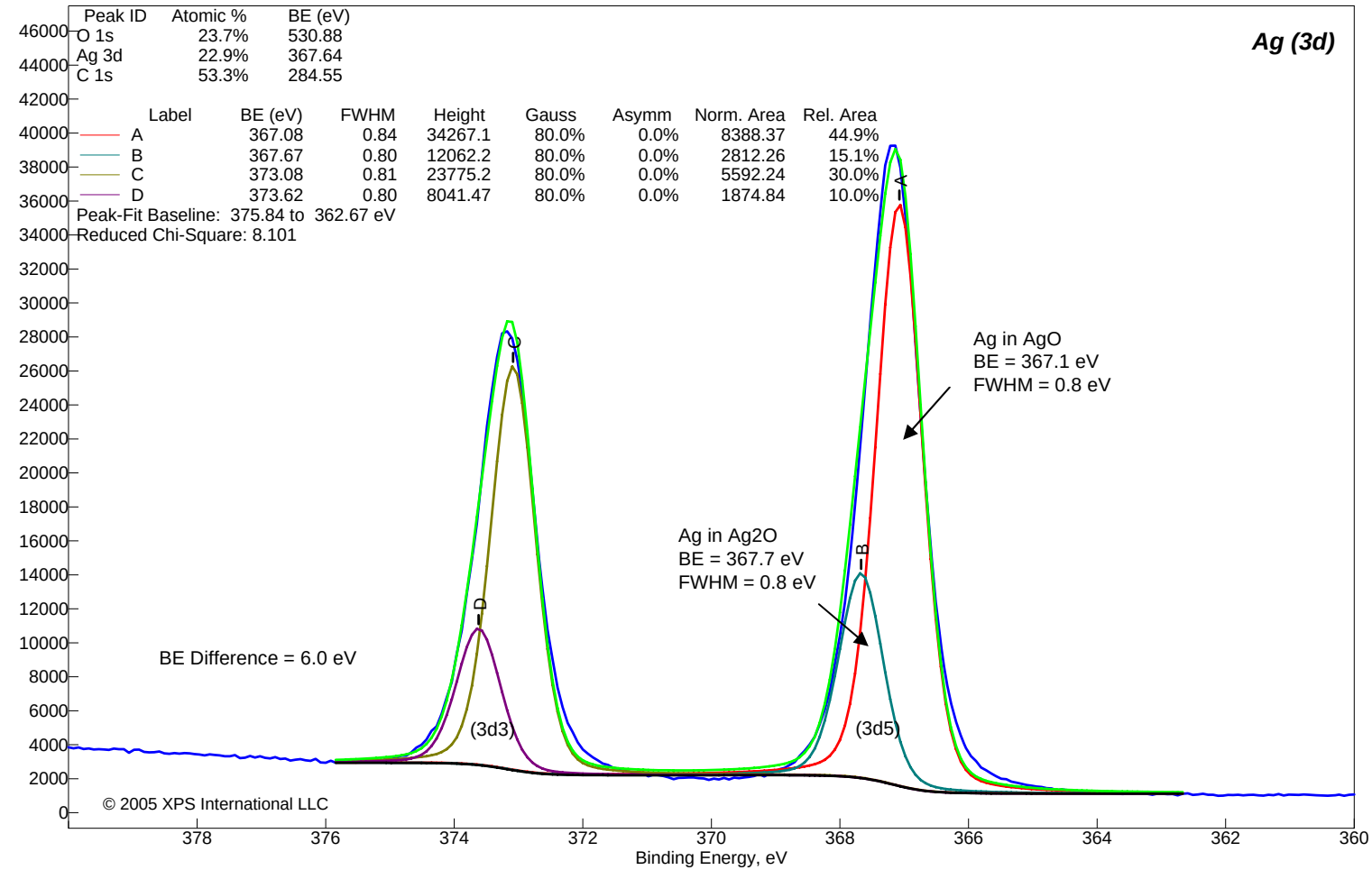


Table
Survey
M-1
O (1s)
C (1s)
VB

Ag_2O

Silver (I) Oxide (FW = 231.74)

Sample Description: Ag2O 5mm pllt 99.99% Aldr Lot# 00105CV scrn 35TOA

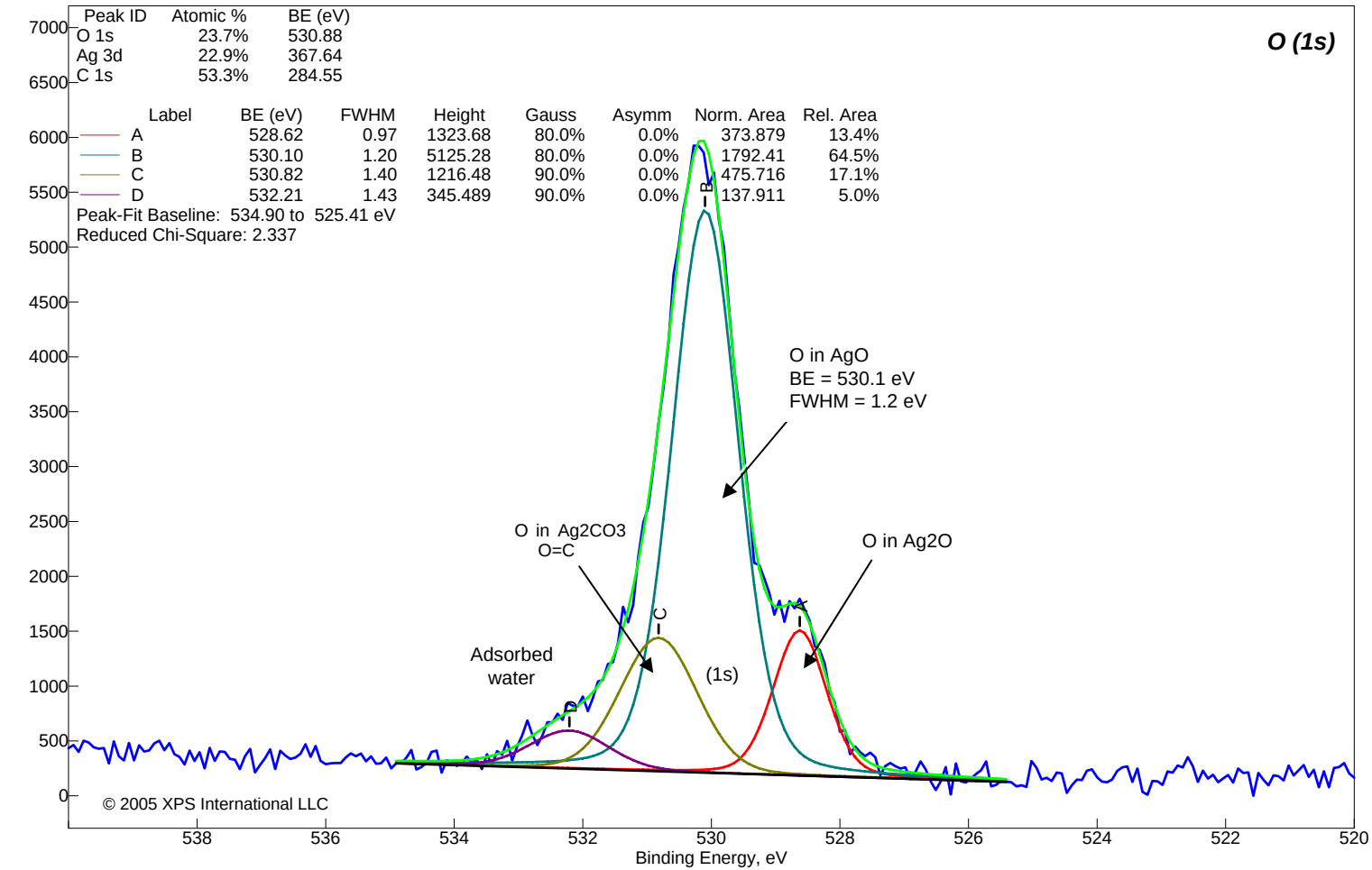


Table
Survey
M-1
O (1s)
C (1s)
VB

Ag_2O

Silver (I) Oxide (FW = 231.74)

Sample Description: Ag2O 5mm pllt 99.99% Aldr Lot# 00105CV scrn 35TOA

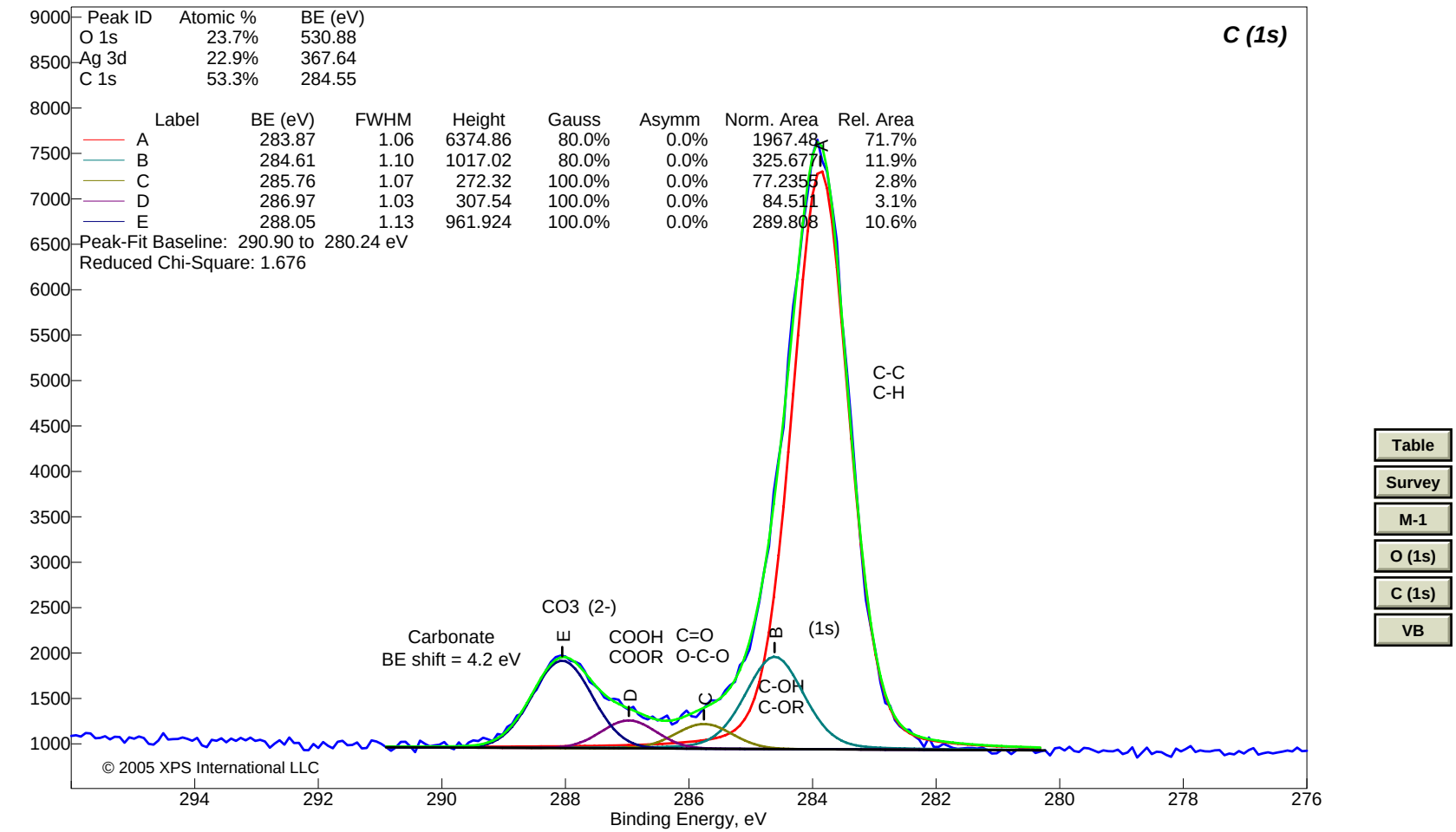


Table
Survey
M-1
O (1s)
C (1s)
VB

Ag_2O

Silver (I) Oxide (FW = 231.74)

Sample Description: Ag2O 5mm pllt 99.99% Aldr Lot# 00105CV scrn 35TOA

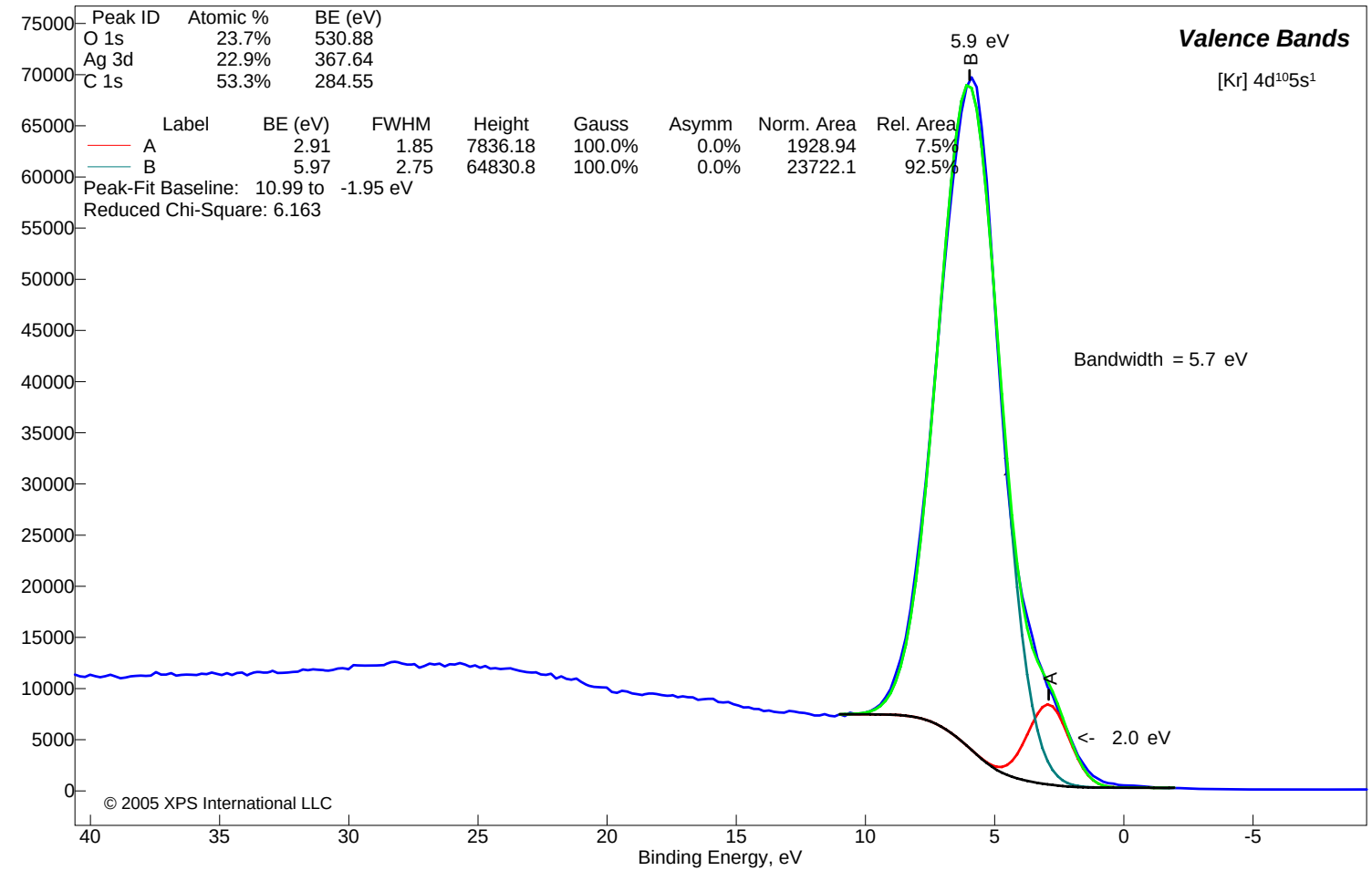


Table
Survey
M-1
O (1s)
C (1s)
VB

Al_2O_3

Aluminum (III) Oxide (FW = 101.96)
Surface Composition Table

Description: Al_2O_3 (99%), analyzed at 90 deg TOA, mesh at 1mm, non-conductive fused into clear glass 1 mm thick, mp 2040 C, d 3.97

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
O 2s	24.0	19.9	0.14	1.2	12,578	
Al 2p	75.9	71.8	0.54	1.2	28,737	23.7%
Al loss	90.5	86.4	0.00	1.5	1,485	
Si 2p	103.2	99.1	0.82	1.5	2,122	
Al 2s	120.8	116.7	0.75	1.2	42,744	
Al loss	144.3	140.2	0.00	1.2	11,965	
Si 2s	155.0	150.9	0.96	1.2	1,481	0.7%
C 1s	286.0	281.9	1.00	1.2	57,477	30.9%
C loss	307.5	303.4	0.00	1.2	4,508	
Ag 3d	369.1	365.0	18.04	1.2	4,186	0.1%
N 1s	401.4	397.3	1.80	1.2	2,528	0.9%
Na Auger	498.1	494.0	3.40	1.2	6,270	
O 1s	532.4	528.3	2.93	1.2	180,659	43.7%
O loss	556.8	552.7	0.00	1.2	95,458	
O Auger	980.1	976.0	0.00	1.2	29,773	

Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Al_2O_3

Aluminum (III) Oxide (FW = 101.96)

Sample Description: Al2O3 (99%) fused into glass 1mm thick
analyzed as received at 90 deg TOA , mesh-screen at 1mm

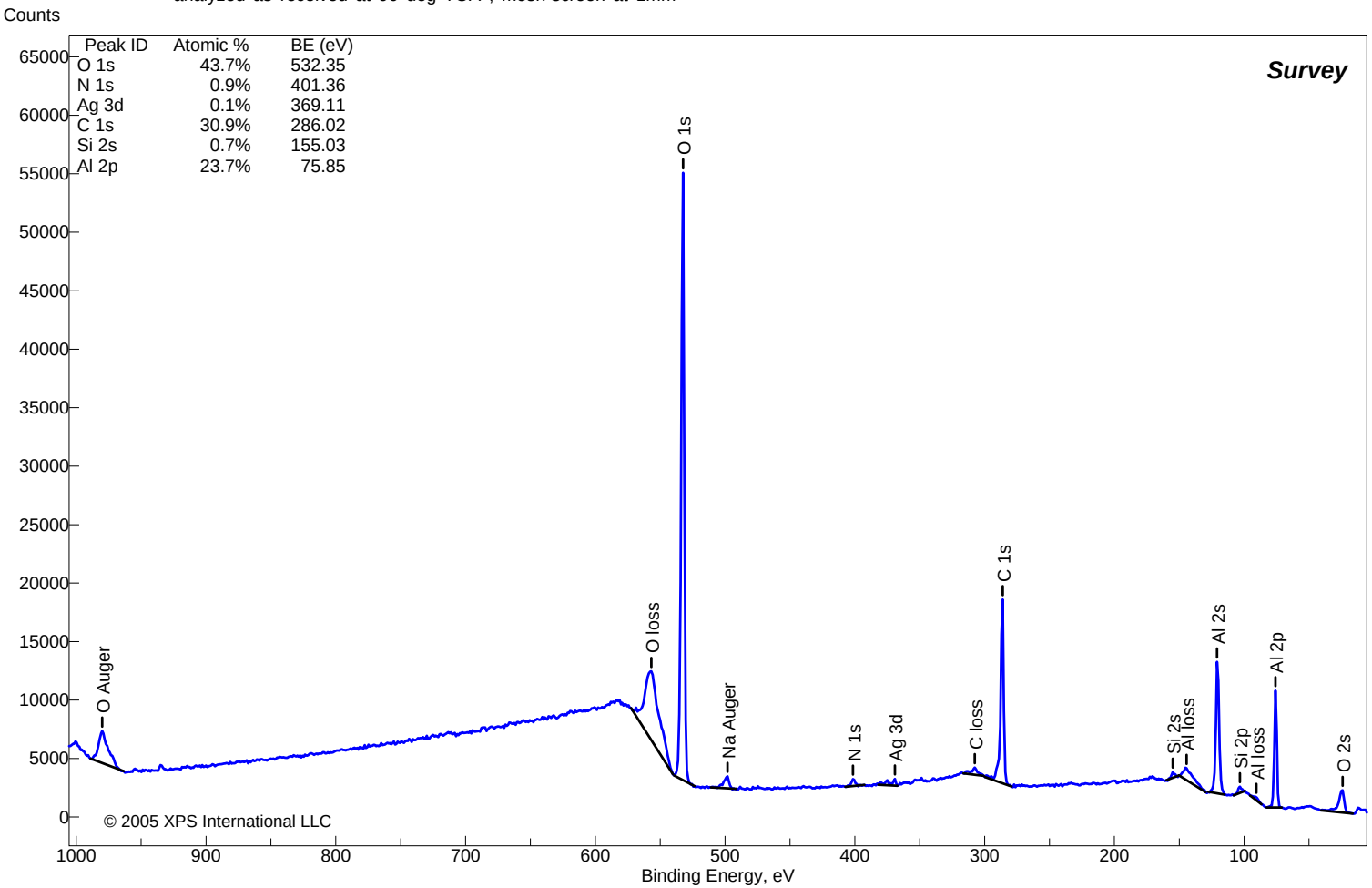


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Al_2O_3

Aluminum (III) Oxide (FW = 101.96)

Sample Description: Fused Al2O3
(as rec'd, surface of 1 mm thick plate, screen, 90 DEG TOA)

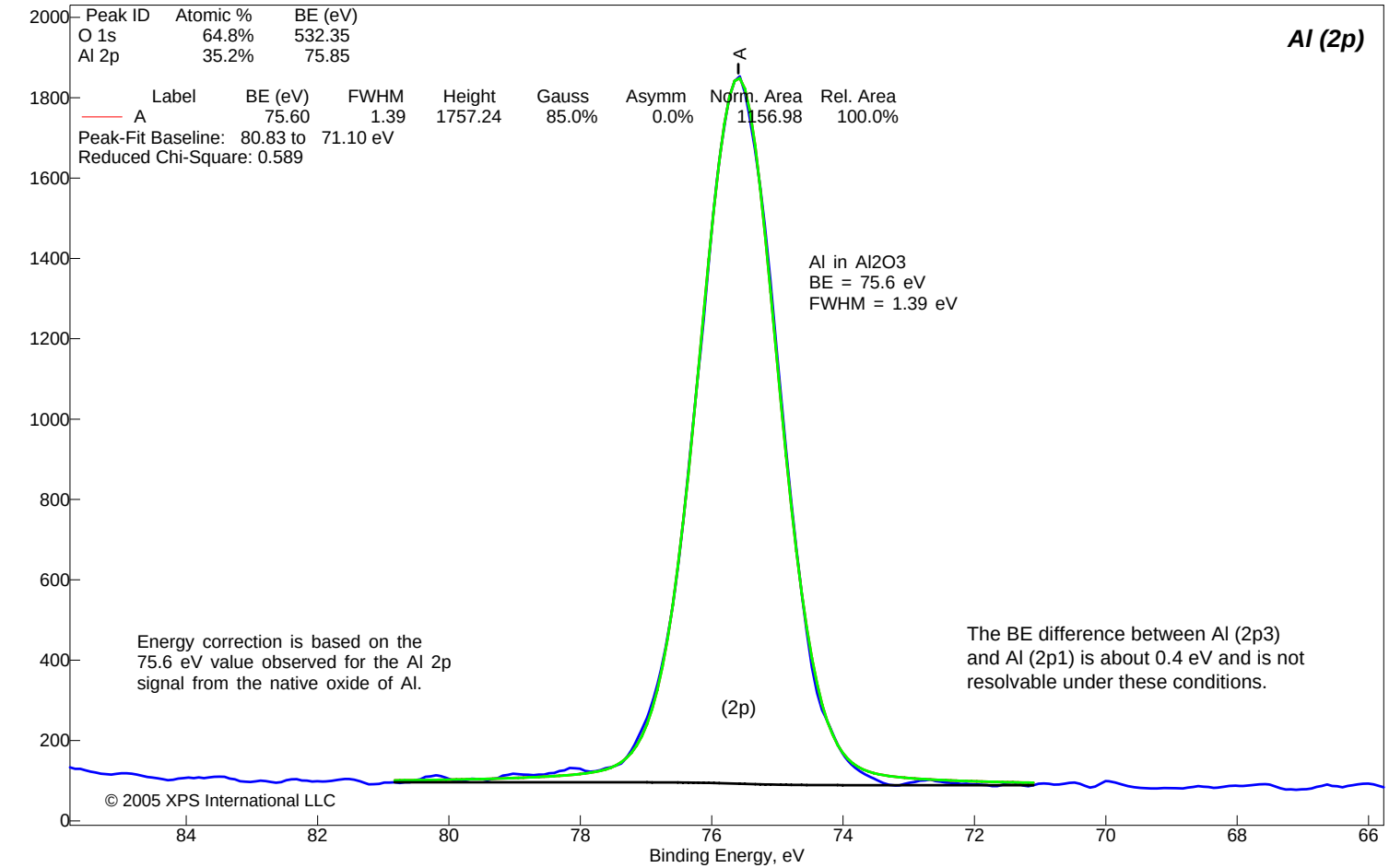


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Al_2O_3

Aluminum (III) Oxide (FW = 101.96)

Sample Description: Fused Al2O3
(as rec'd, surface of 1 mm thick plate, screen, 90 DEG TOA)

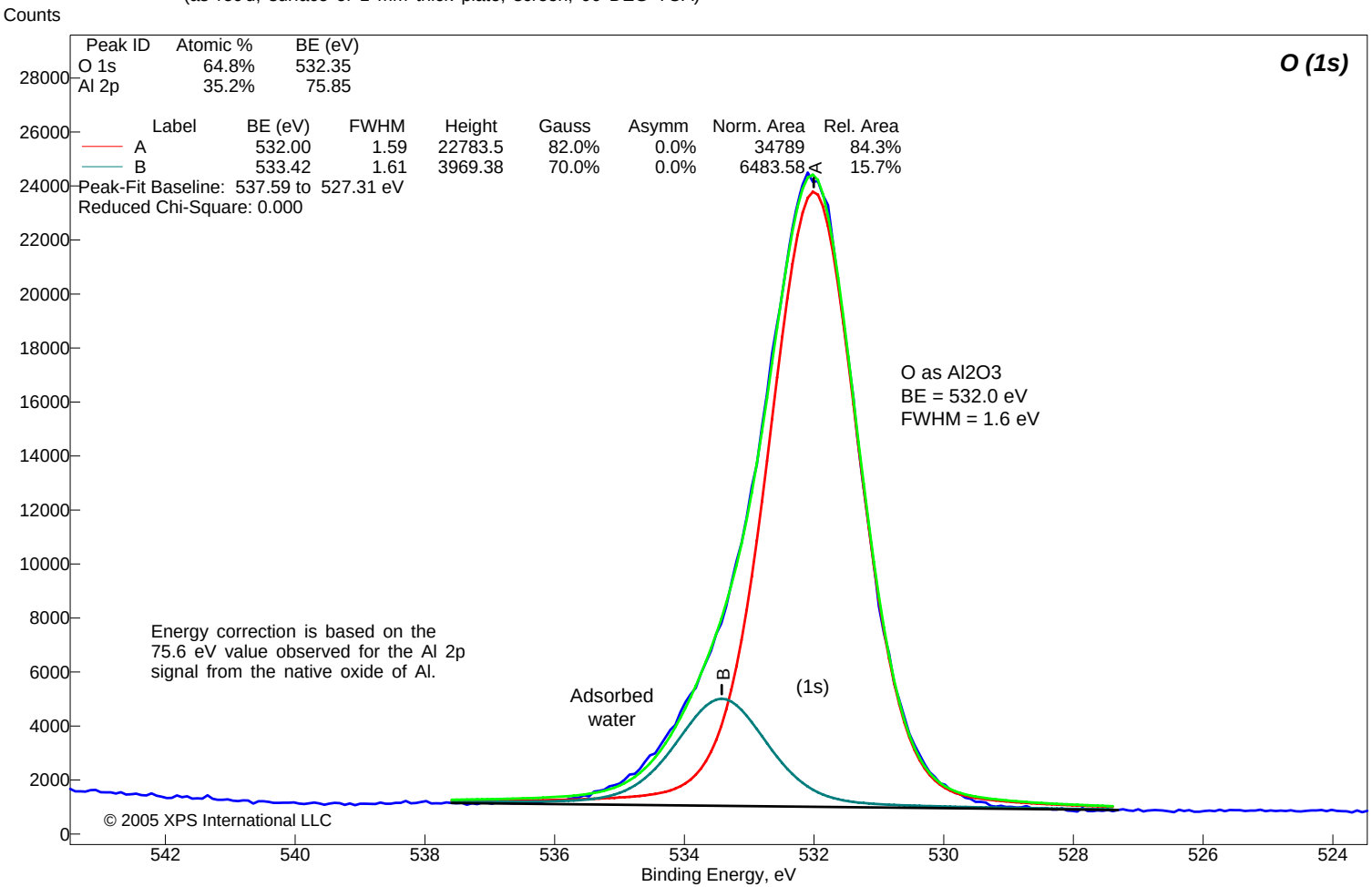


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Aluminum (III) Oxide (FW = 101.96)

Sample Description: Fused Al2O3
(as rec'd, surface of 1 mm thick plate, screen, 90 DEG TOA)

Counts

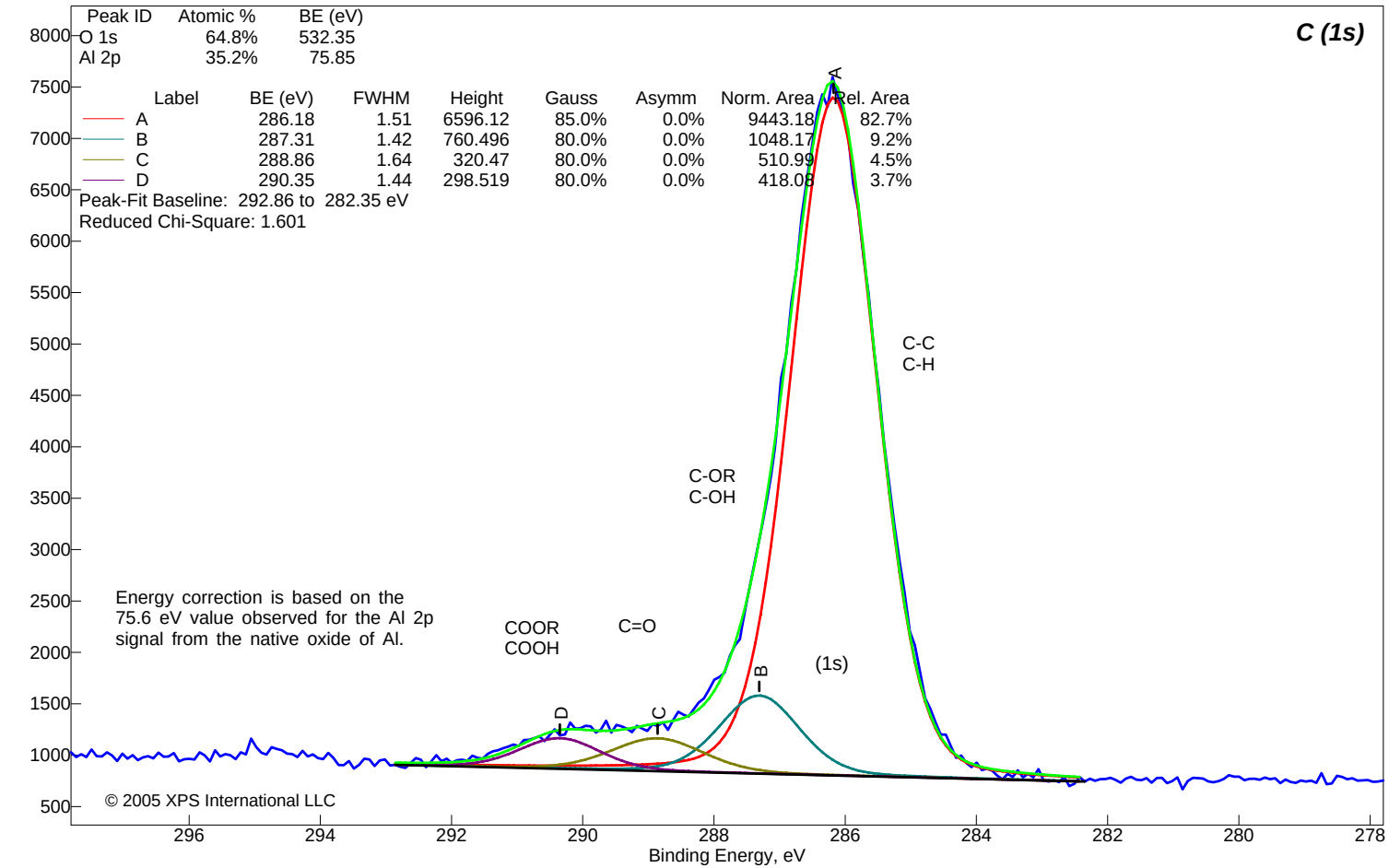


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Aluminum (III) Oxide (FW = 101.96)

Sample Description: Fused Al2O3
(as rec'd, surface of 1 mm thick plate, screen, 90 DEG TOA)

Counts

Peak ID	Atomic %	BE (eV)
O 1s	64.8%	532.35
Al 2p	35.2%	75.85

Label	BE (eV)	FWHM	Height	Gauss	Asymm	Norm. Area	Rel. Area
A	6.06	2.79	1132.68	85.0%	0.0%	1804.28	30.0%
B	8.28	2.94	977.755	85.0%	0.0%	1637.05	27.3%
C	11.34	2.86	1572.69	85.0%	0.0%	2563.92	42.7%

Peak-Fit Baseline: 16.06 to 1.16 eV
Reduced Chi-Square: 1.613

Label	BE (eV)	FWHM	Height	Gauss	Asymm	Norm. Area	Rel. Area
A	24.16	3.22	4934.31	85.0%	0.0%	9056.7	81.4%
B	27.04	2.52	933.813	85.0%	0.0%	1340.82	12.0%
C	30.92	3.22	399.824	85.0%	0.0%	734.645	6.6%

Peak-Fit Baseline: 35.67 to 19.78 eV
Reduced Chi-Square: 2.536

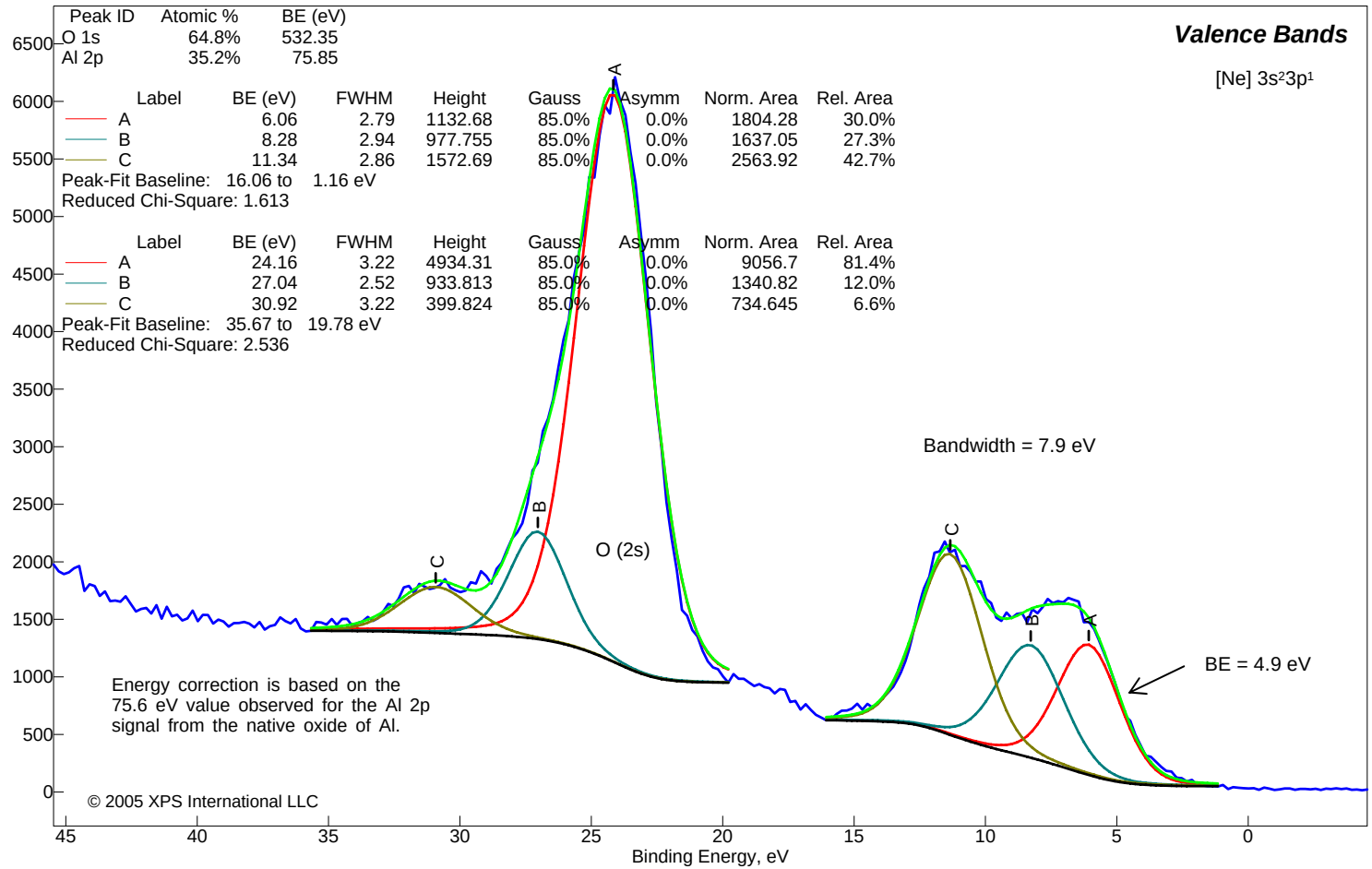


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Al_2O_3

Aluminum (III) Oxide (FW = 101.96)

Sample Description: Fused Al2O3
(as rec'd, surface of 1 mm thick plate, screen, 90 DEG TOA)

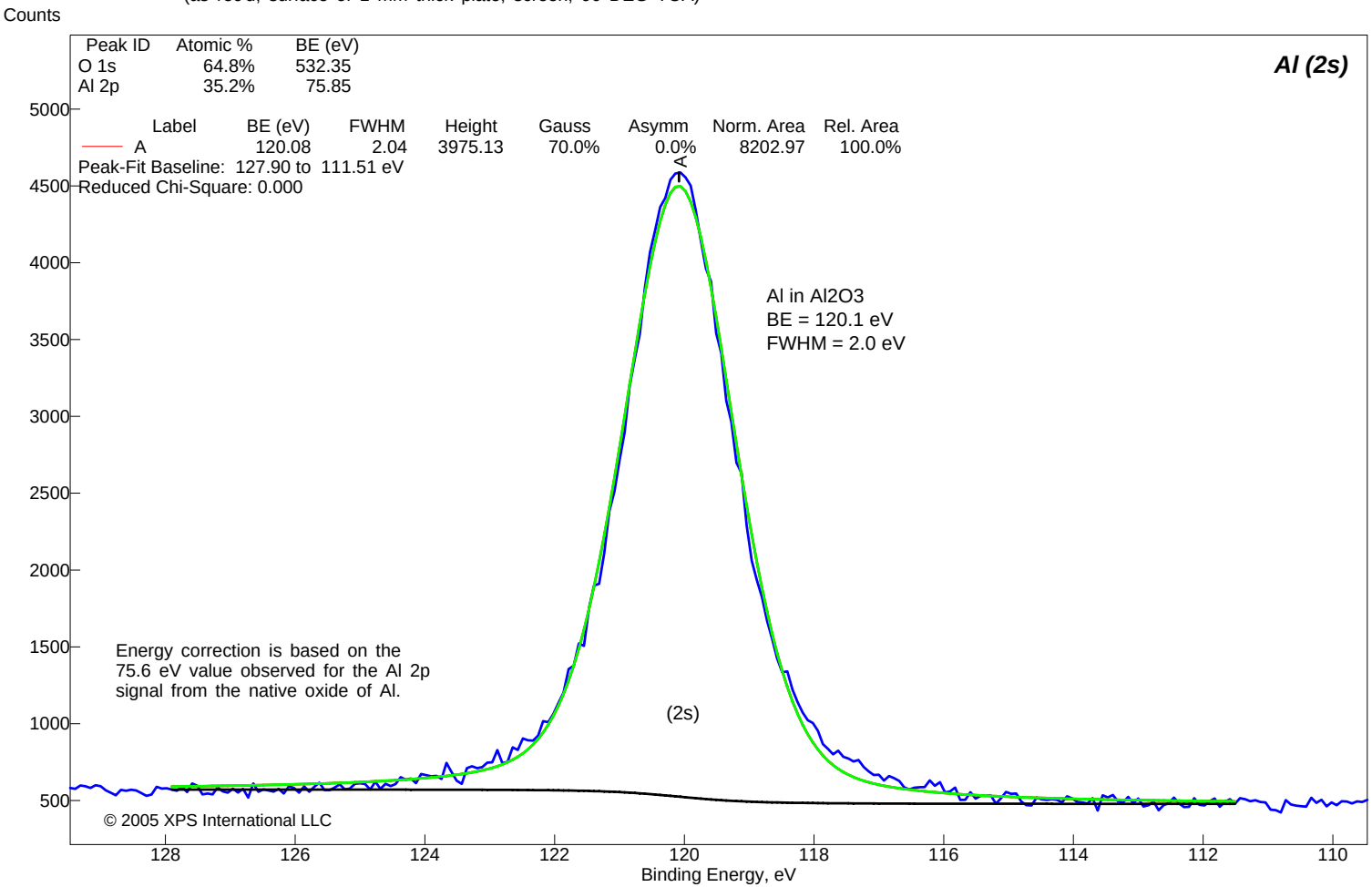


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)
Surface Composition Table

Description: AlOOH (Diaspore, Al_2O_3-H_2O) a natural mineral, analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
O 2s	24.2	24.2	0.15	1.4	2,945	
Al 2p	75.0	75.0	0.54	1.4	6,323	
Al KLL-1	99.4	99.4	0.22	1.4	2,556	
Al 2s	119.9	119.9	0.75	1.4	9,912	24.8%
Al loss	144.4	144.4	0.00	1.4	4,440	
C 1s	286.1	286.1	1.00	1.4	11,569	26.1%
C loss	303.7	303.7	0.00	1.4	1,695	
O 1s	532.5	532.5	2.93	1.4	46,298	49.1%
O loss	555.9	555.9	0.00	1.4	25,489	
O loss	581.3	581.3	0.00	1.4	1,853	
O KLL-1	979.2	979.2	0.70	1.4	6,850	

Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)

Sample Description: AlOOH (Diaspore, Al2O3-H2O), analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air, mp xxx, d xxx

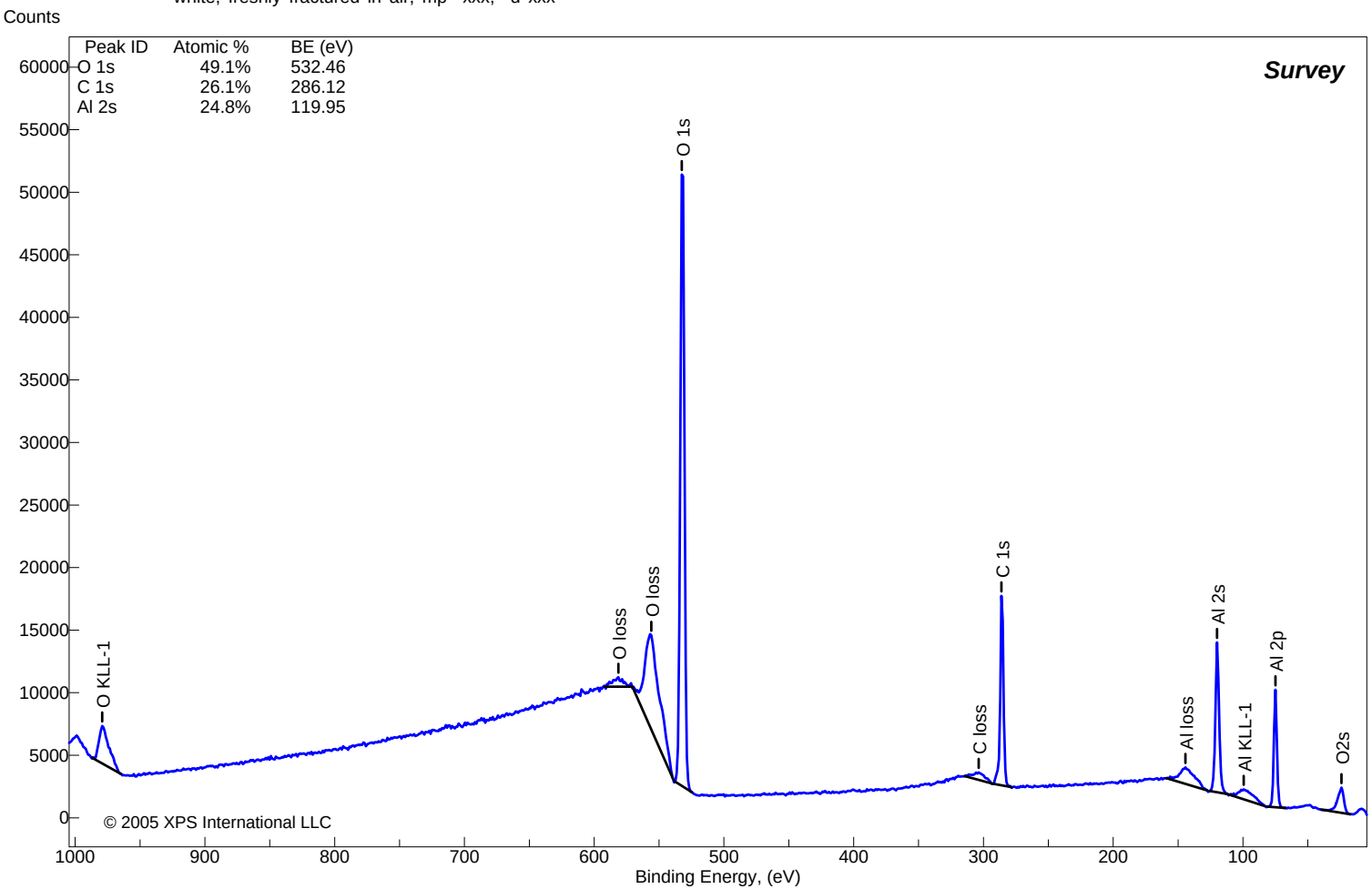


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)

Sample Description: AlOOH (Diaspore, Al2O3-H2O), analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air, mp xxx, d xxx

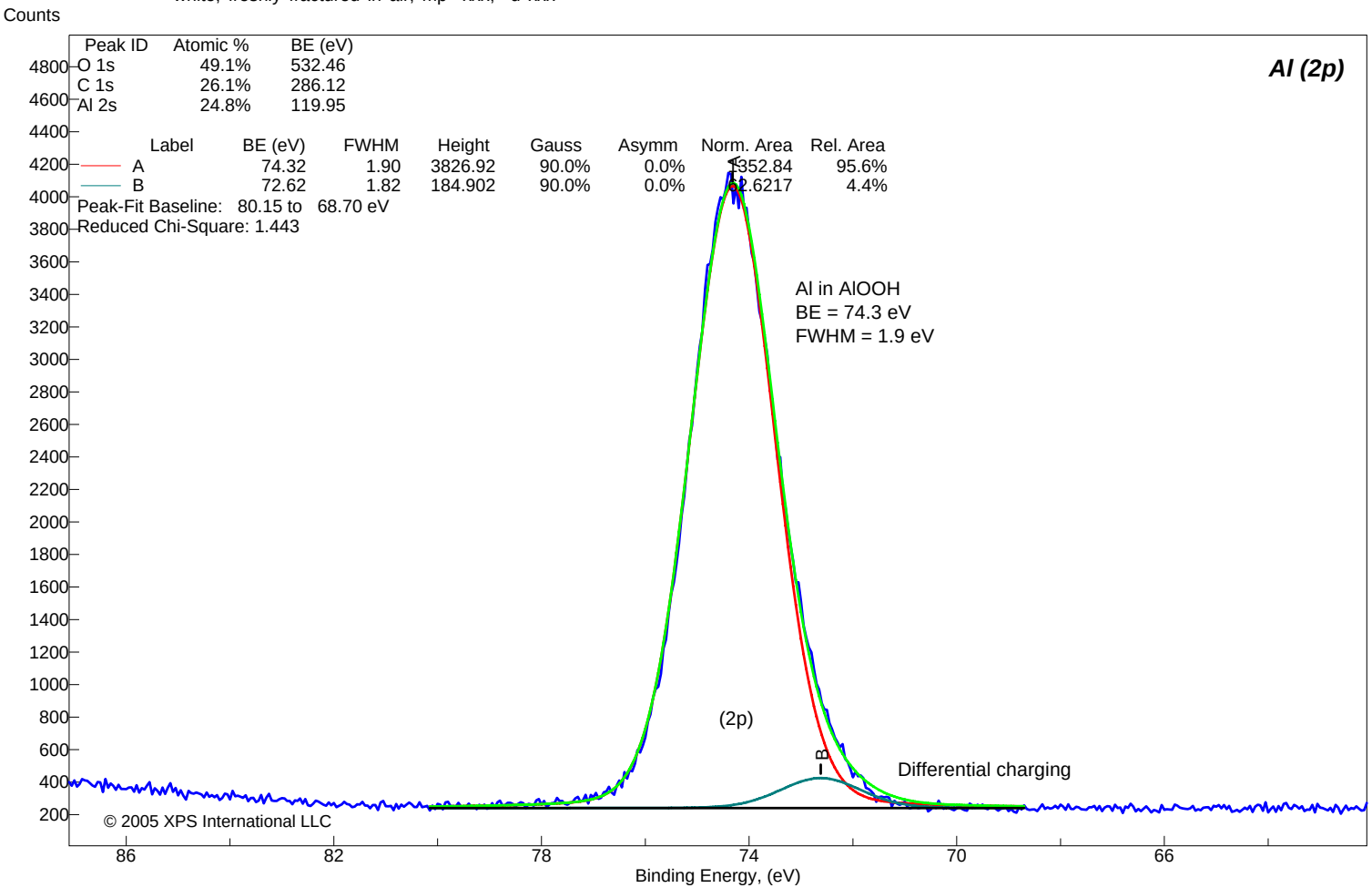


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)

Sample Description: AlOOH (Diaspore, Al2O3-H2O), analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air, mp xxx, d xxx

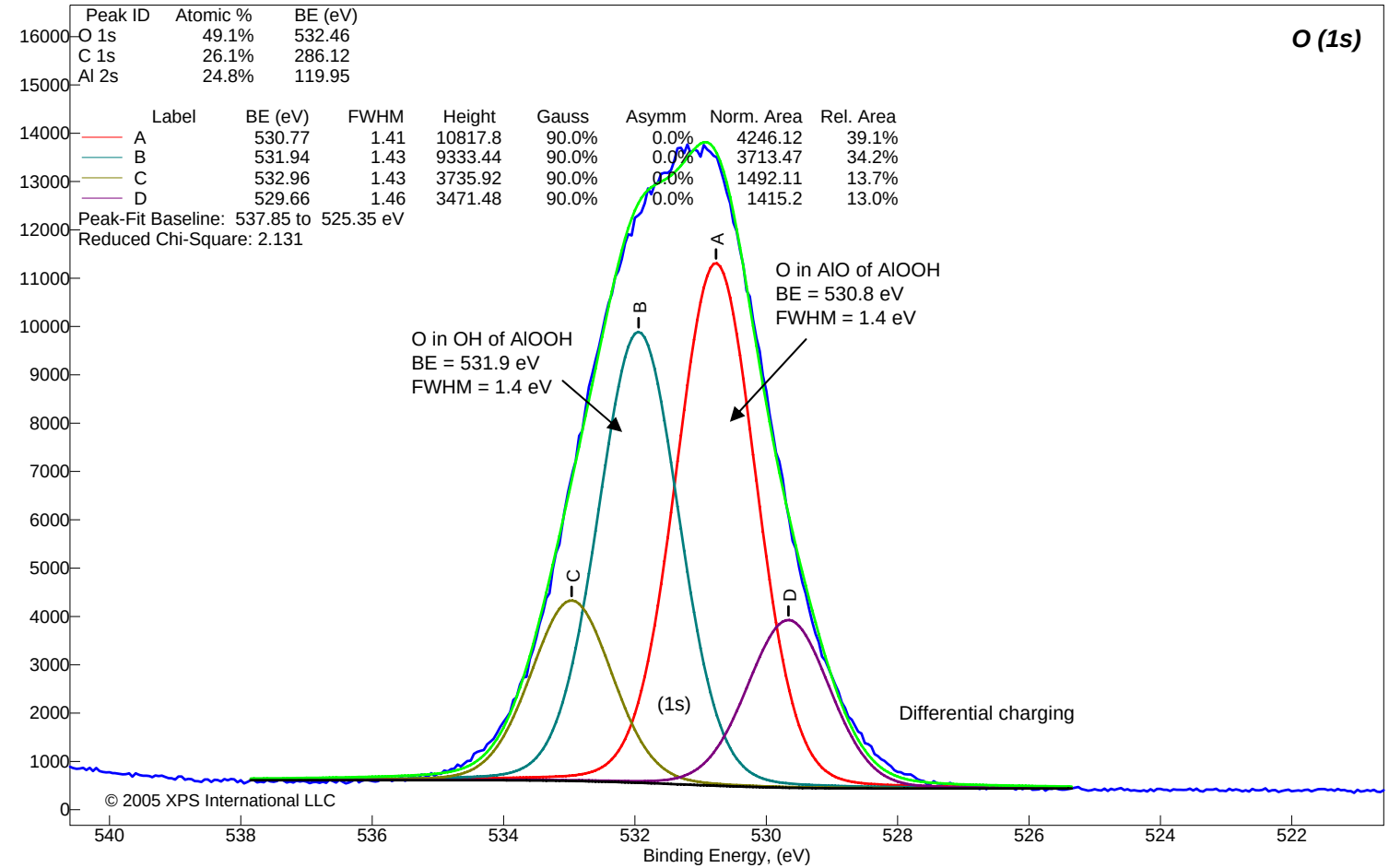


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)

Sample Description: AlOOH (Diaspore, Al2O3-H2O), analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air, mp xxx, d xxx

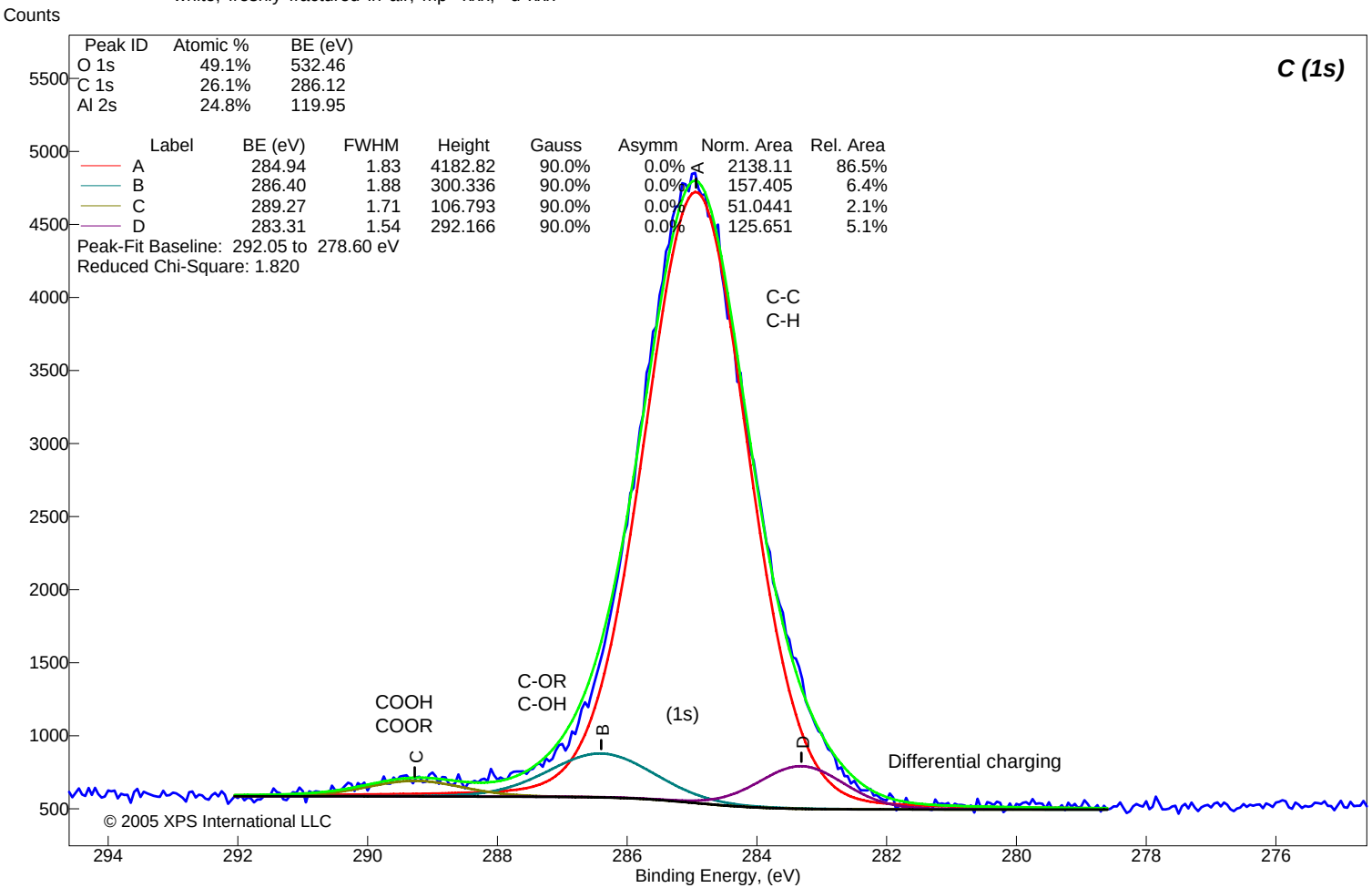


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)

Sample Description: AlOOH (Diaspore, Al2O3-H2O), analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air, mp xxx, d xxx

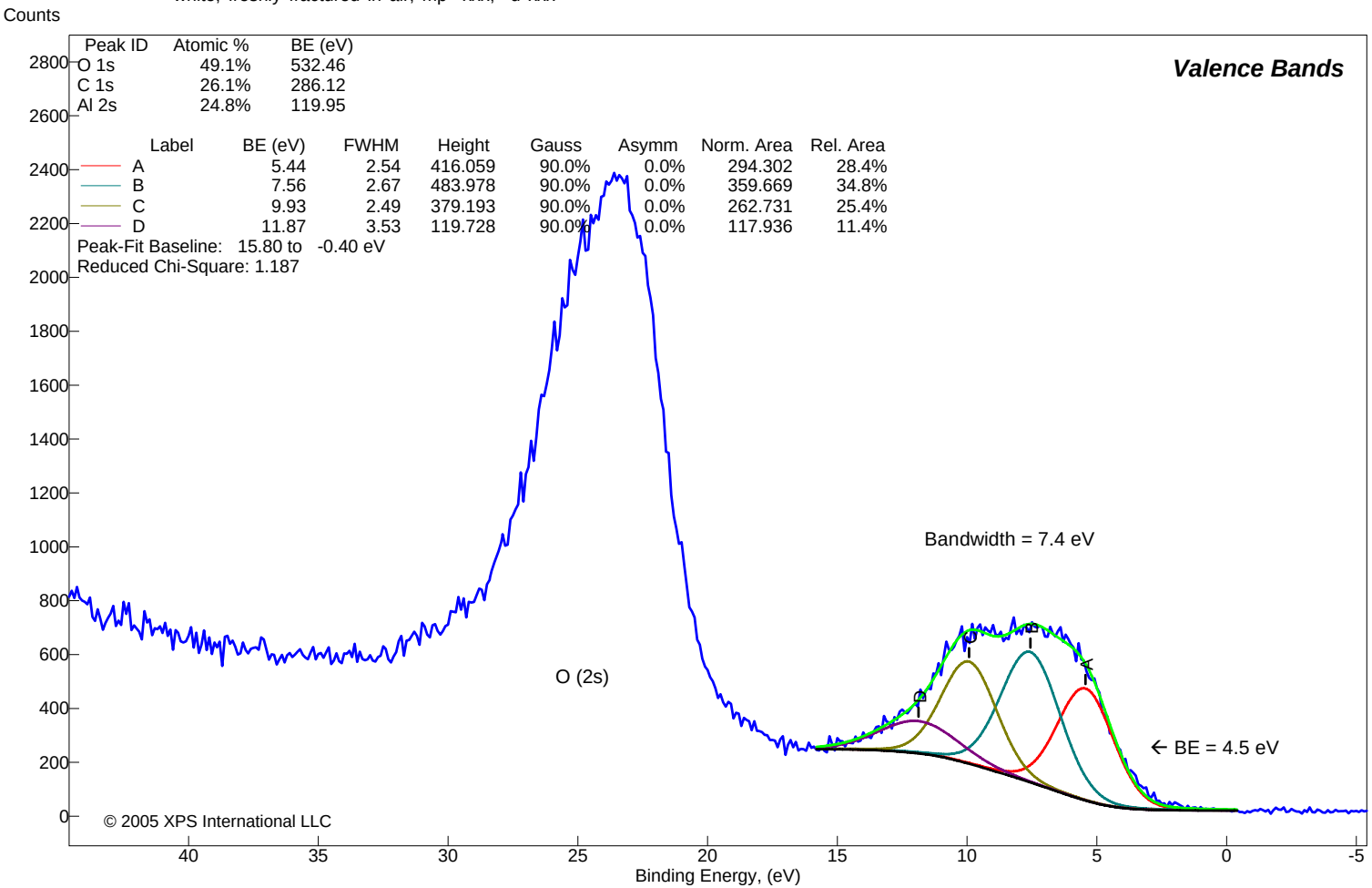


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)

Sample Description: AlOOH (Diaspore, Al2O3-H2O), analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air, mp xxx, d xxx

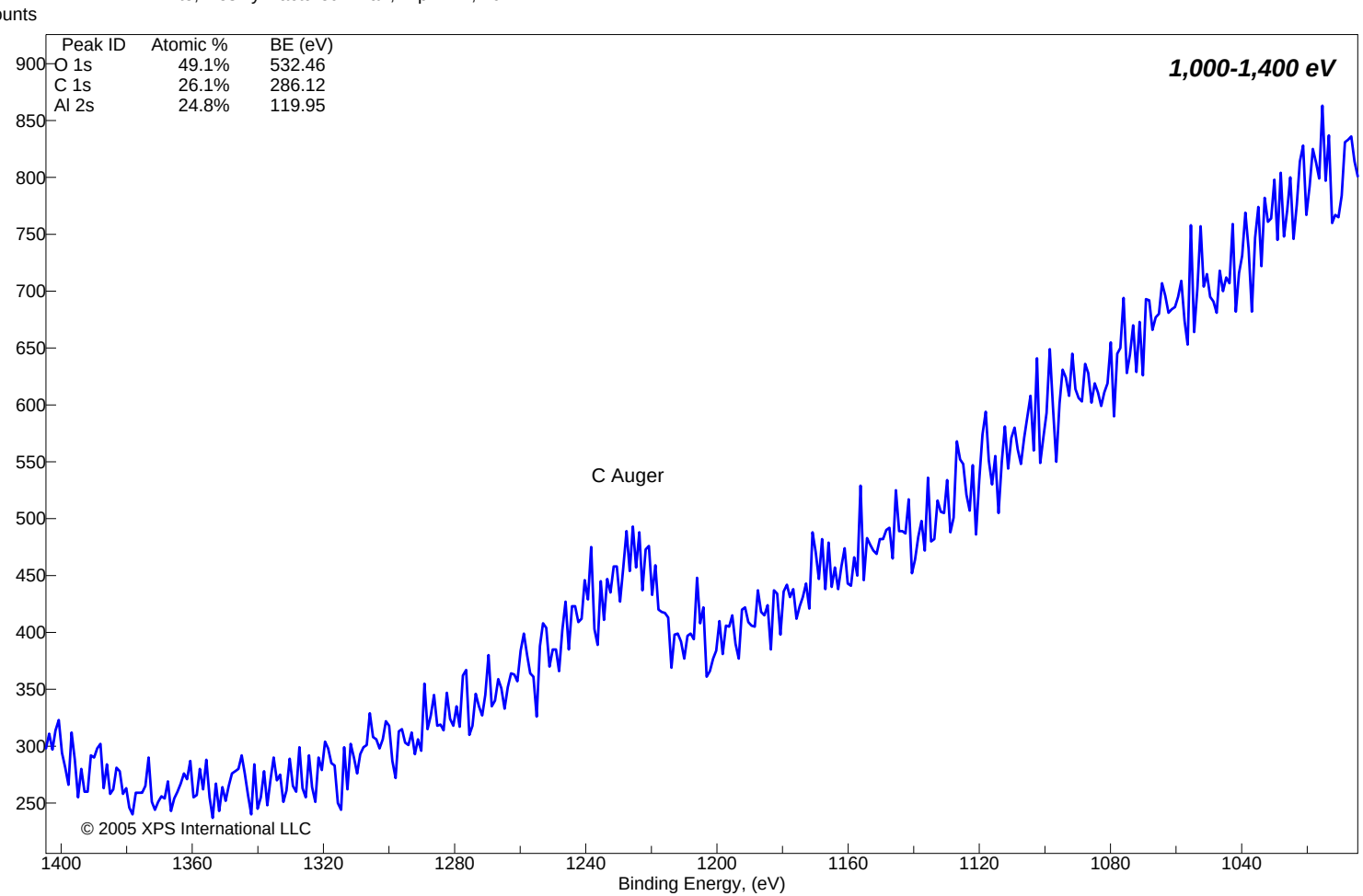


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)

Sample Description: AlOOH (Diaspore, Al2O3-H2O), analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air, mp xxx, d xxx

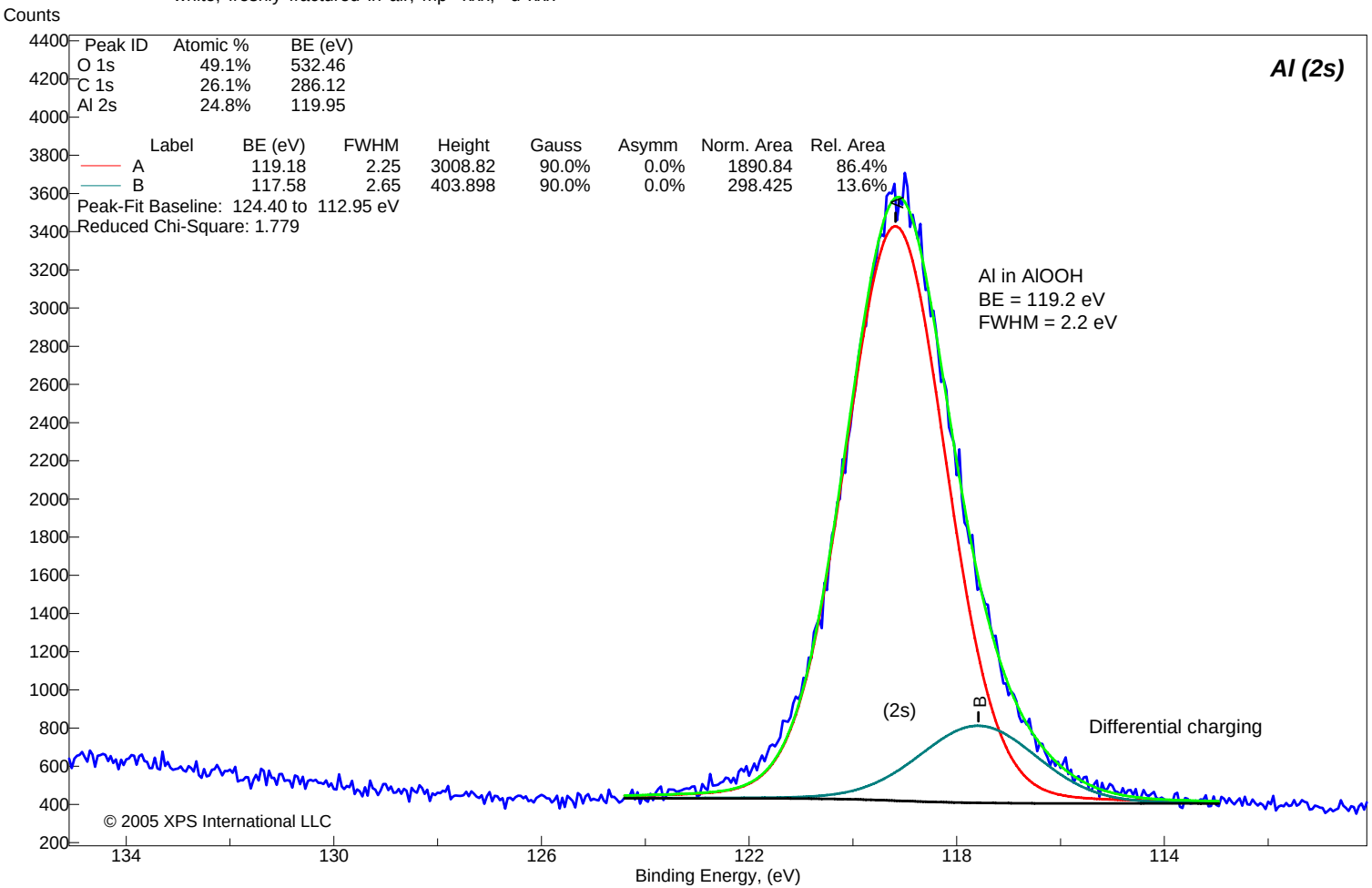


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

AlOOH
Diaspore

Aluminum (III) Oxy-hydroxide (FW = 59.99)

Sample Description: AlOOH (Diaspore, Al2O3-H2O), analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white, freshly fractured in air, mp xxx, d xxx

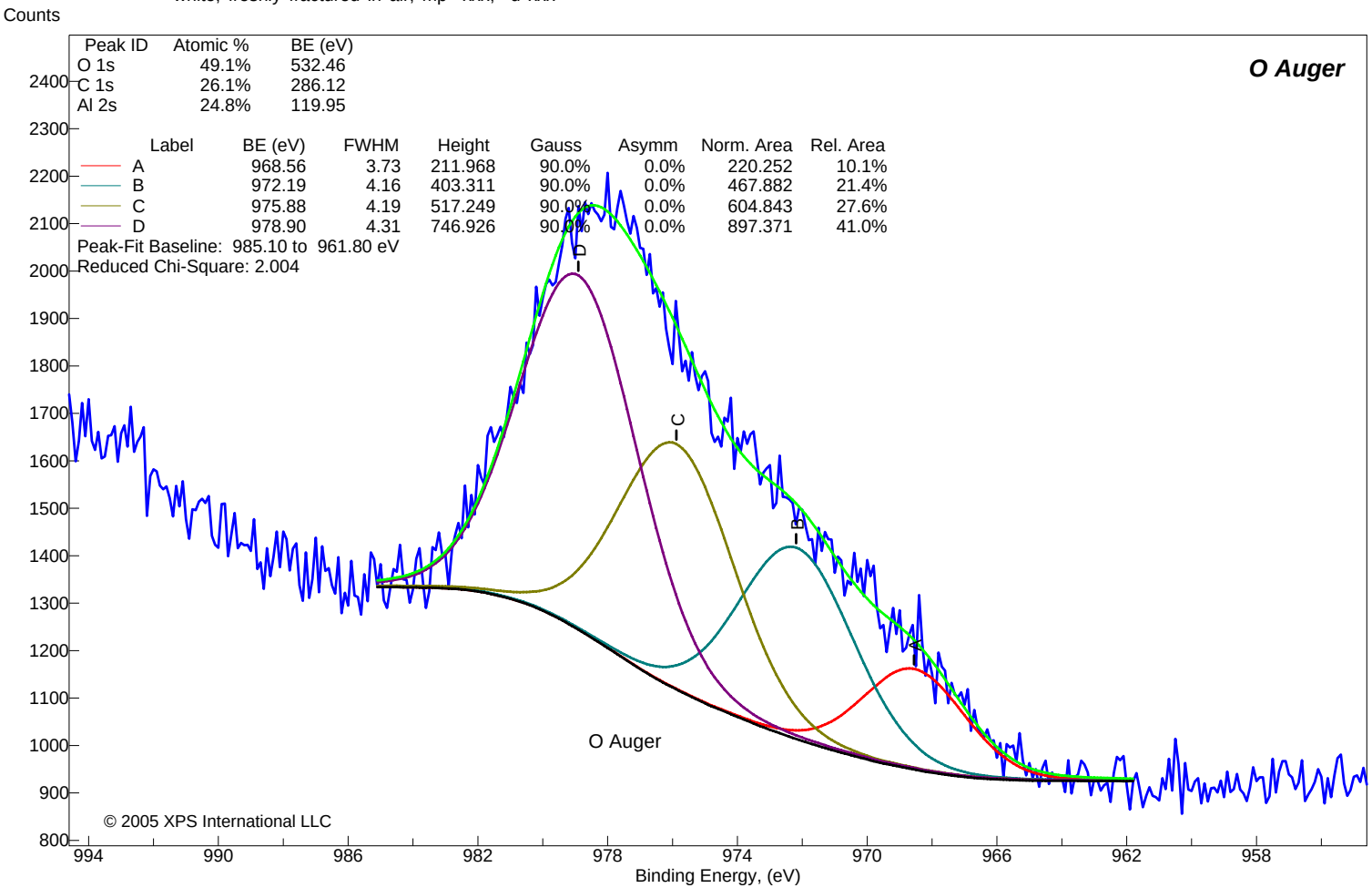


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

$Al(OH)_3$

Aluminum (III) Hydroxide (FW = 78.00)
Surface Composition Table

Description: $Al(OH)_3$ (Tech.) from Perfect Parts Chem. Co., analyzed at 35 deg TOA, no mesh, non-conductive white powder pressed onto double sided tape, dec to Al2O3 >300 C, sol in aq. alkaline soln, HCl, H_2SO_4

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
O 2s	24.0	20.2	0.14	0.6	3,409	
Al 2p	73.9	70.1	0.54	0.6	4,885	
Al loss	96.4	92.6	0.00	0.6	1,419	
Al 2s	118.9	115.1	0.75	1.5	7,230	18.0%
Al loss	142.3	138.5	0.00	0.6	2,350	
C 1s	285.0	281.2	1.00	1.5	9,833	22.4%
O 1s	532.4	528.6	2.93	1.5	54,136	59.5%
O loss	555.8	552.0	0.00	0.6	28,217	
O KLL-1	978.1	974.3	0.70	0.6	13,859	

Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

$Al(OH)_3$

Aluminum (III) Hydroxide (FW = 78.00)

Sample Description: Al(OH)3 (Tech. Grade) from Perfect Parts Chemical Co.
analyzed at 35 deg TOA, pressed onto double sided tape, no mesh-screen

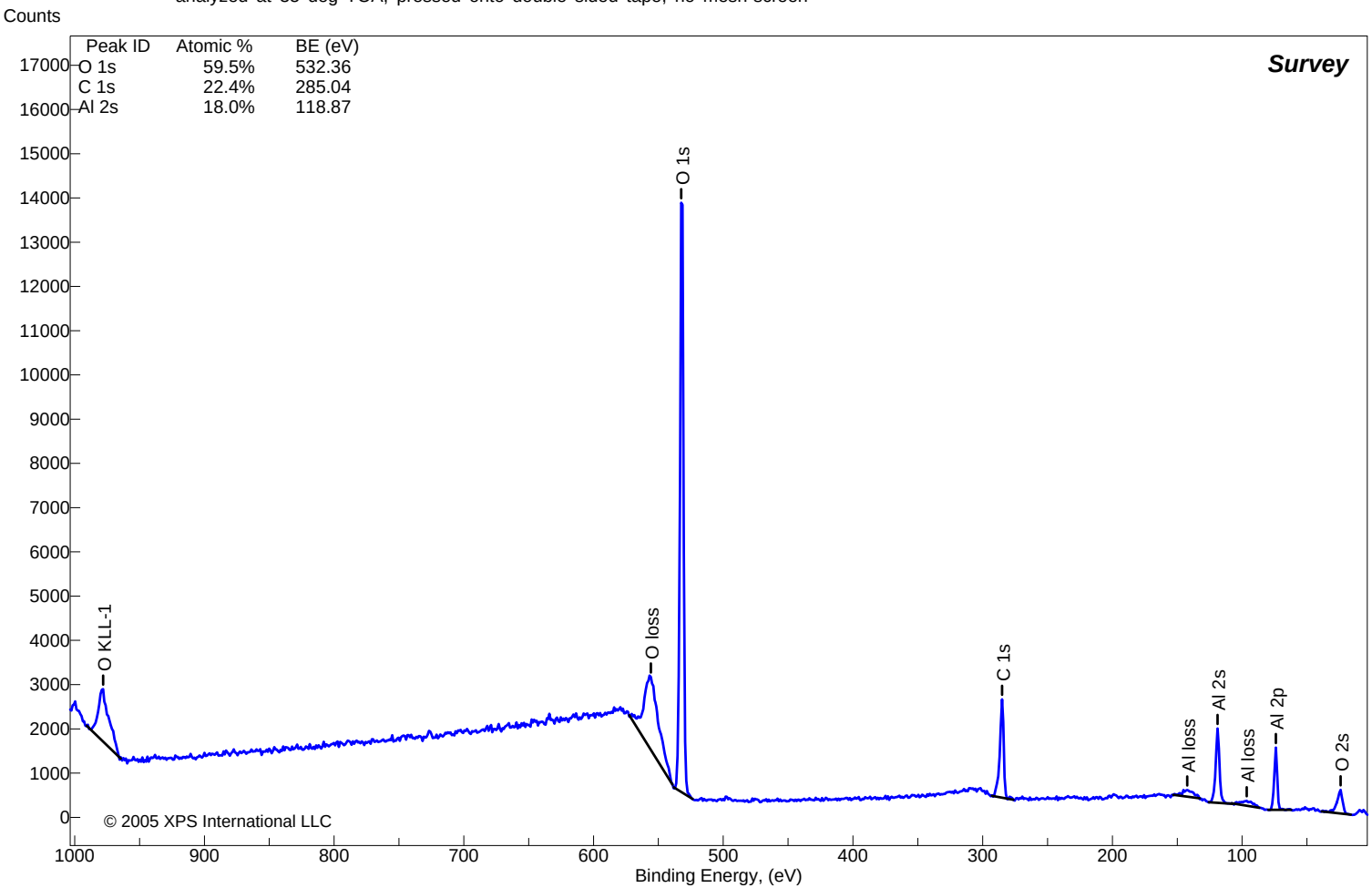


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Aluminum (III) Hydroxide (FW = 78.00)

Sample Description: ALUMINUM HYDROXIDE (Al(OH)3) powder/tape (no mesh)
TECHNICAL GRADE, PERFECT PARTS CHEMICAL CO.

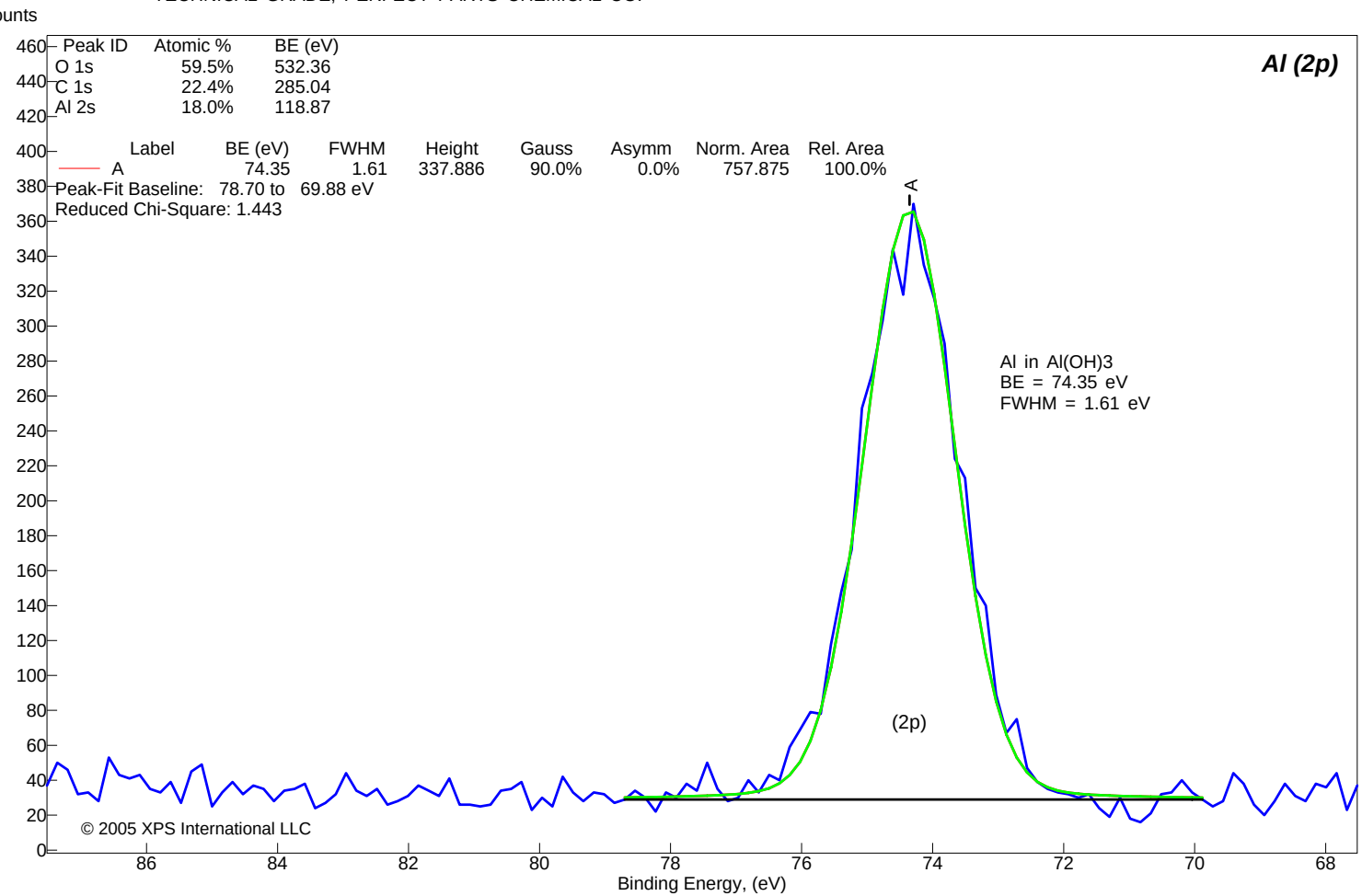


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Aluminum (III) Hydroxide (FW = 78.00)

Sample Description: ALUMINUM HYDROXIDE (Al(OH)3) powder/tape (no mesh)
TECHNICAL GRADE, PERFECT PARTS CHEMICAL CO.

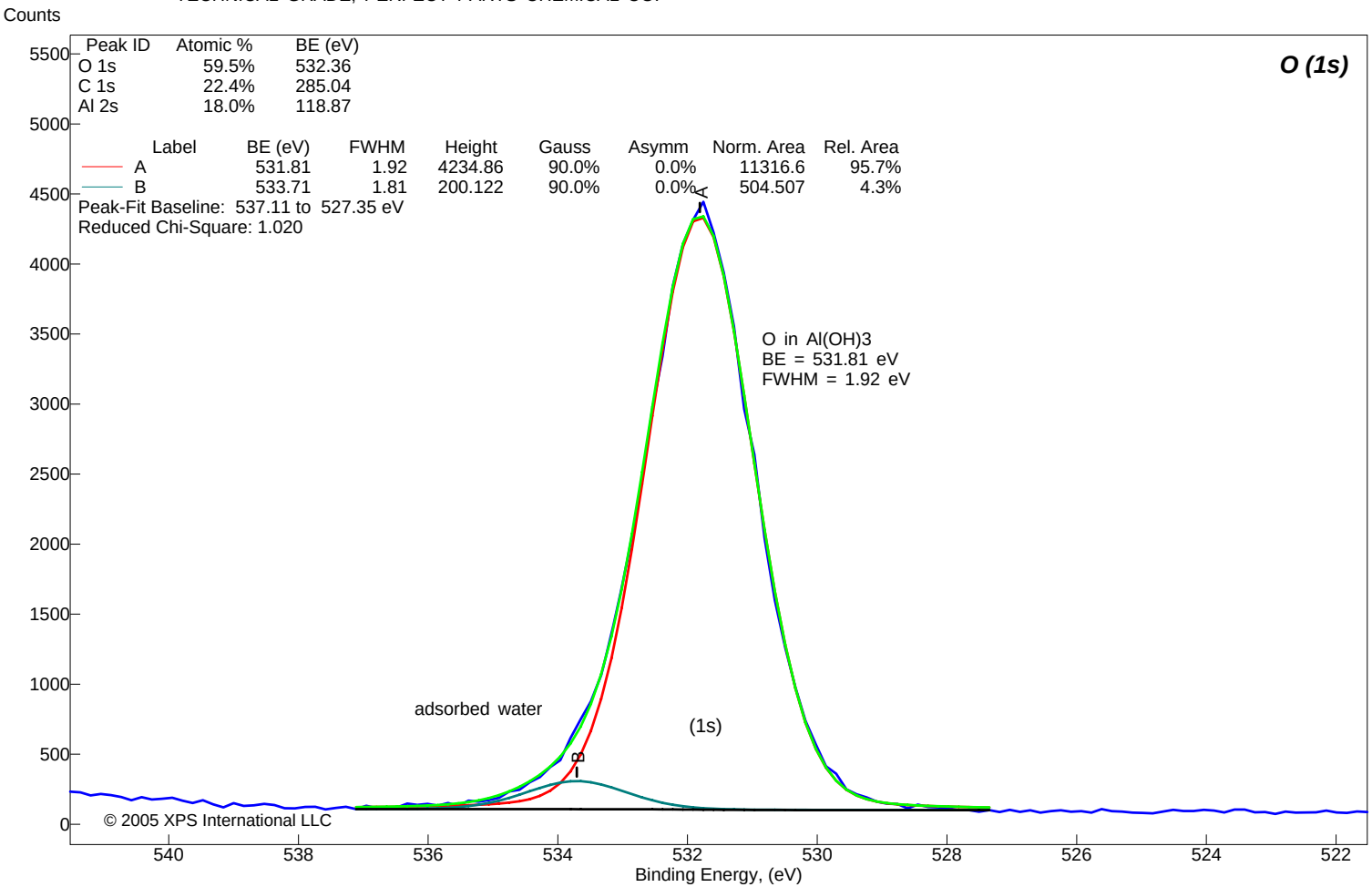


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Aluminum (III) Hydroxide (FW = 78.00)

Sample Description: ALUMINUM HYDROXIDE (Al(OH)3) powder/tape (no mesh)
TECHNICAL GRADE, PERFECT PARTS CHEMICAL CO.

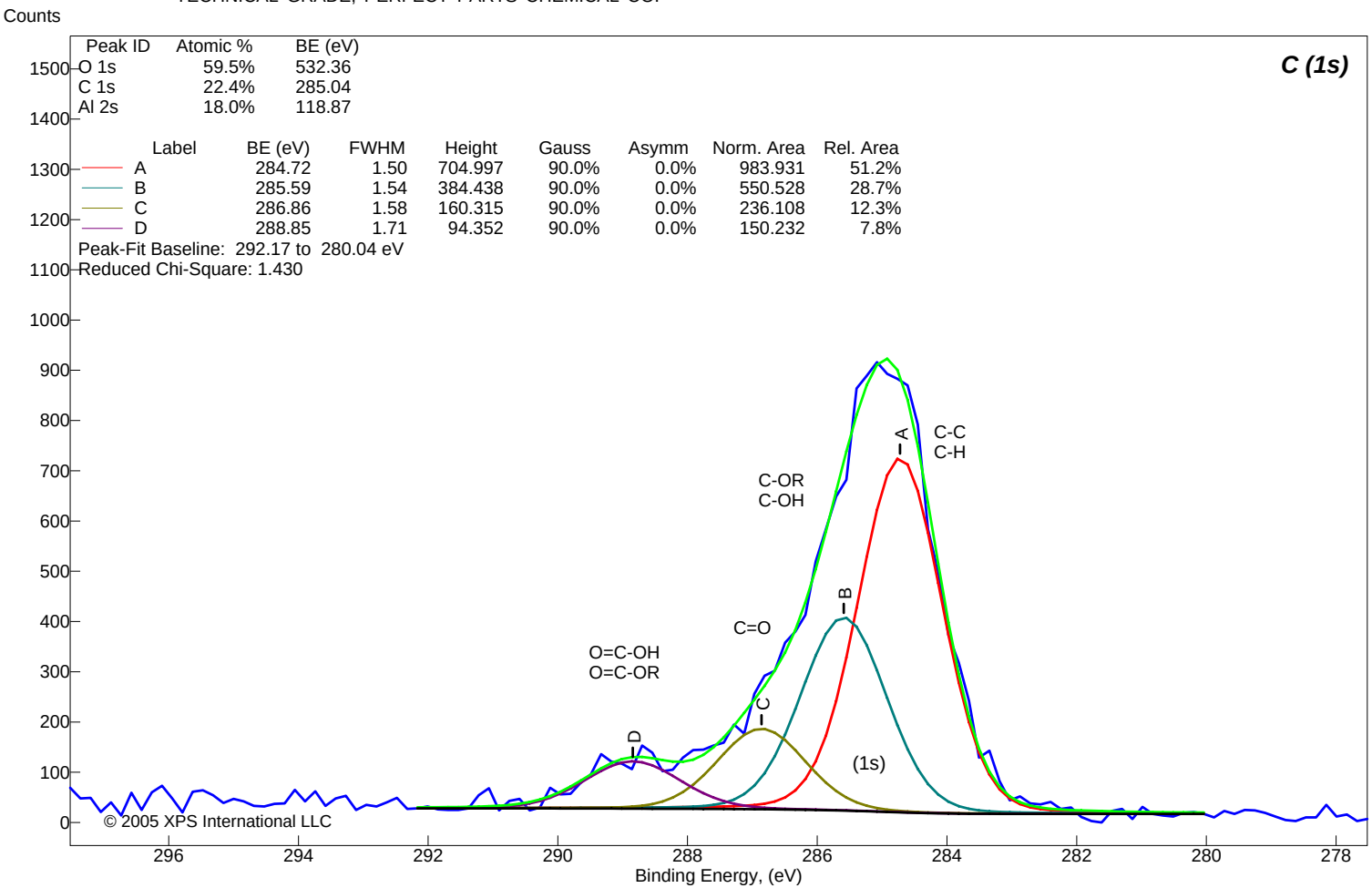


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

Aluminum (III) Hydroxide (FW = 78.00)

Sample Description: ALUMINUM HYDROXIDE (Al(OH)3) powder/tape (no mesh)
TECHNICAL GRADE, PERFECT PARTS CHEMICAL CO.

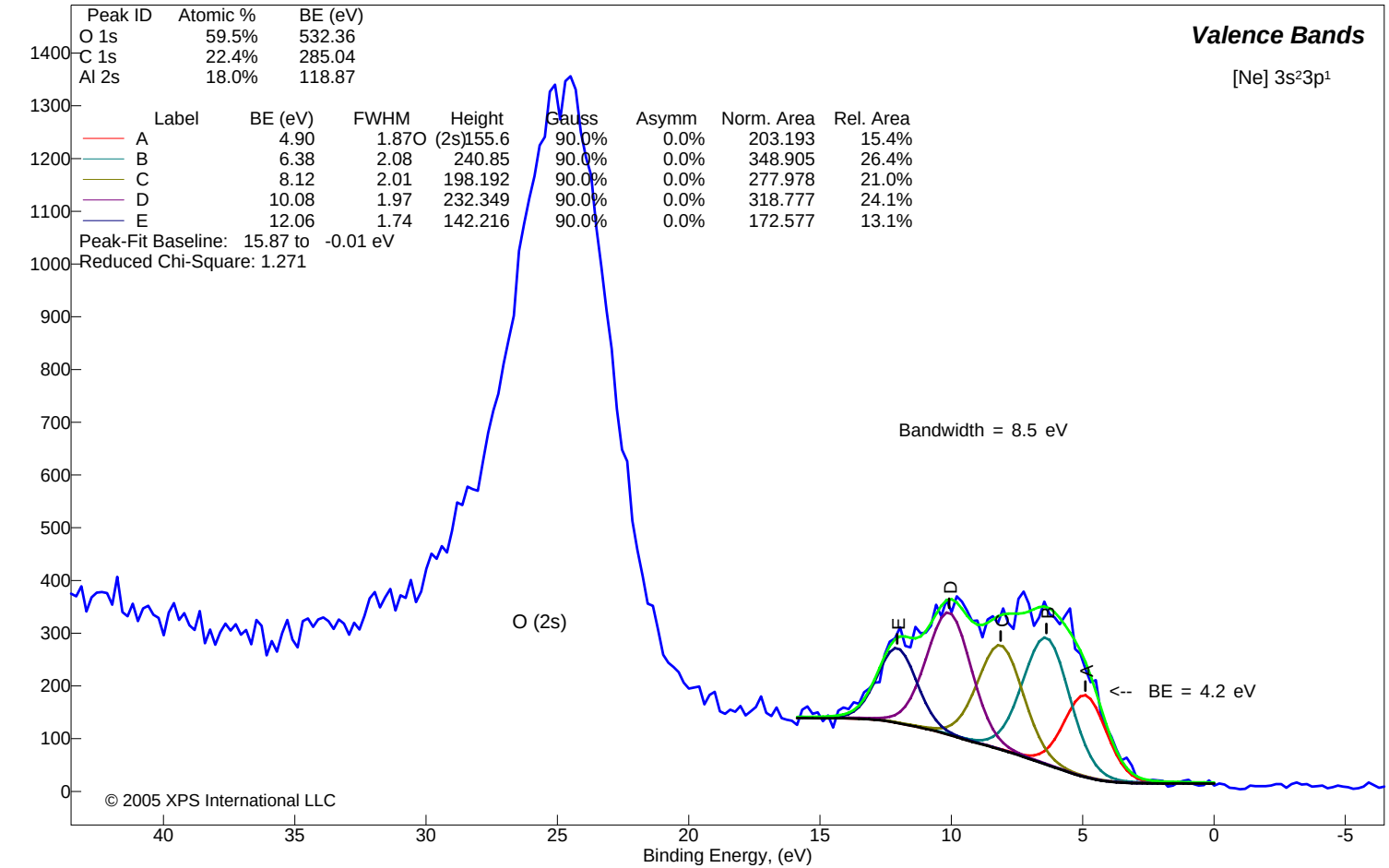


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

$Al(OH)_3$

Aluminum (III) Hydroxide (FW = 78.00)

Sample Description: ALUMINUM HYDROXIDE (Al(OH)3) powder/tape (no mesh)
TECHNICAL GRADE, PERFECT PARTS CHEMICAL CO.

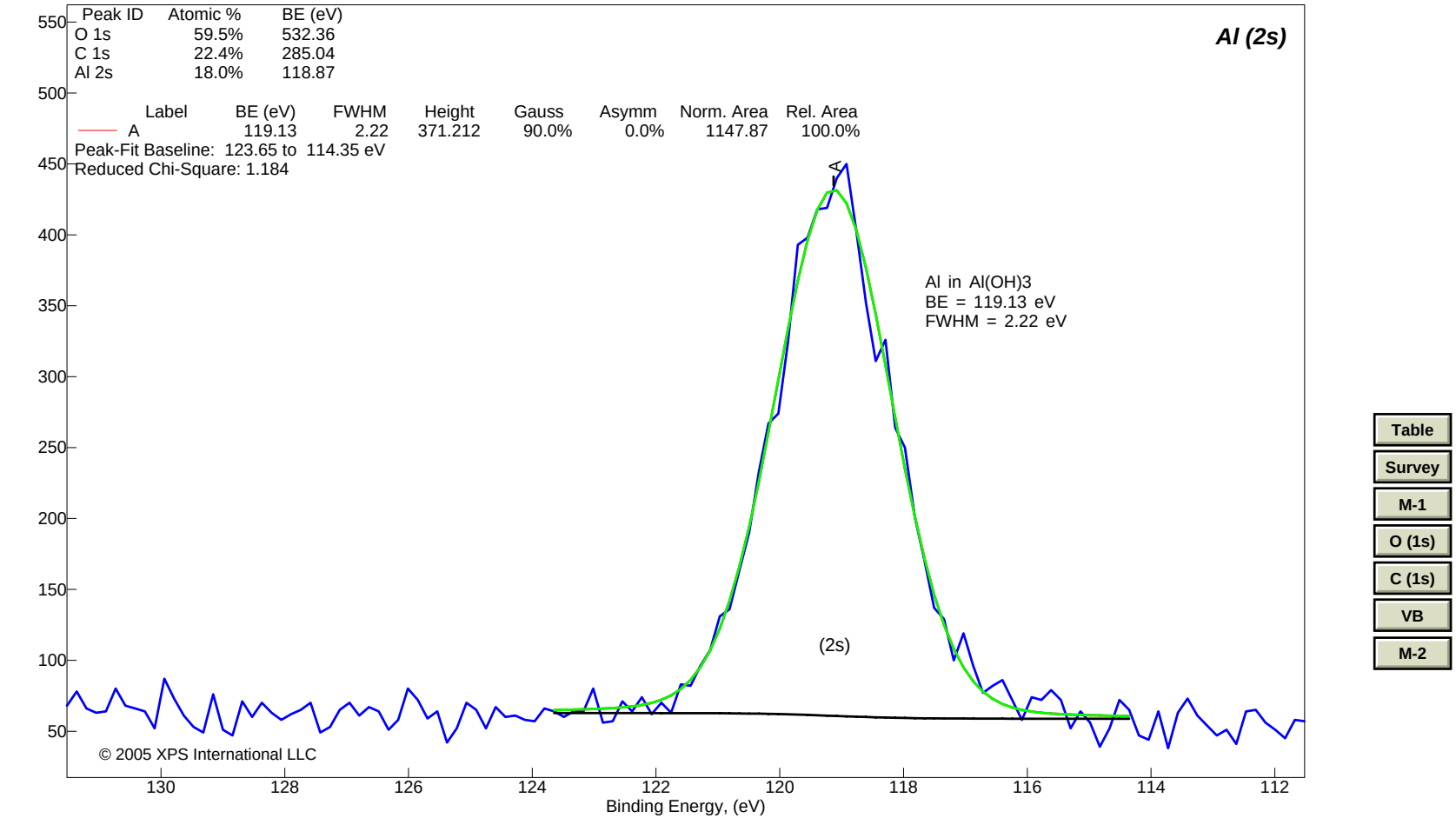


Table
Survey
M-1
O (1s)
C (1s)
VB
M-2

As_2O_3

Arsenic (III) Oxide (FW = 197.84)
Surface Composition Table

Description: As_2O_3 (99.995%) from Aldrich Lot# 04445CW, analyzed at 90 deg TOA, mesh at 1mm, non-conductive white powder pressed into 3 mm pellet, mp 312 C, d 3.7, sol in boiling water, HCl, insol. in alcohol

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
As 4p	10.4	10.4	0.12	1.4	1,945	
O 2s	25.0	25.0	0.14	1.4	6,487	
As 3d	45.6	45.6	1.82	1.4	68,690	
As loss	67.1	67.1	0.00	1.4	29,942	
As 3p	145.3	145.3	4.07	1.4	128,540	29.6%
As loss	167.8	167.8	0.00	1.4	17,059	
As Auger	208.8	208.8	0.00	1.4	39,047	
As Auger	233.2	233.2	0.00	1.4	145,382	
As LMM-3	268.4	268.4	0.40	1.4	270,869	
C 1s	286.0	286.0	1.00	1.4	8,106	8.9%
As Auger	341.7	341.7	0.00	1.4	62,610	
As Auger	367.2	367.2	0.00	1.4	48,861	
As Auger	377.9	377.9	0.00	1.4	54,150	
As loss	400.4	400.4	0.00	1.4	10,545	
As Auger	438.5	438.5	0.00	1.4	45,111	
As Auger	464.9	464.9	0.00	1.4	82,310	
O 1s	532.4	532.4	2.93	1.4	119,613	61.5%
O loss	553.9	553.9	0.00	1.4	51,082	
O KLL-1	977.1	977.1	0.70	1.4	25,155	

Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

As_2O_3

Arsenic (III) Oxide (FW = 197.84)

Sample Description: As2O3 (99.995%) from Aldrich lot# 04445CW
pressed into 3 mm pellet, analyzed at 90 deg TOA, mesh-screen at 1 mm height

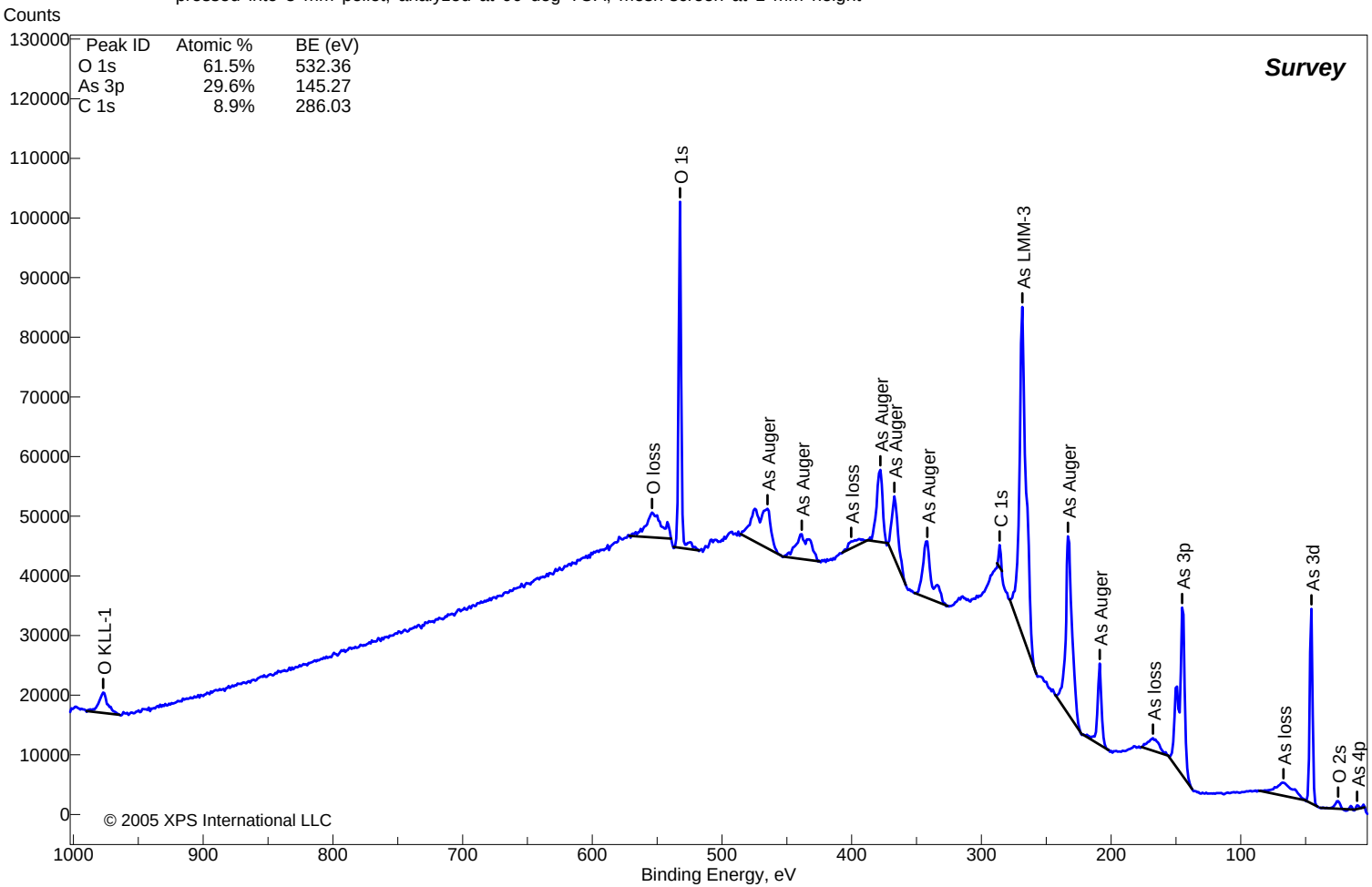


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

As_2O_3

Arsenic (III) Oxide (FW = 197.84)

Sample Description: As2O3 99.995% Aldr# 04445CW 3mm plt 90 TOA mesh

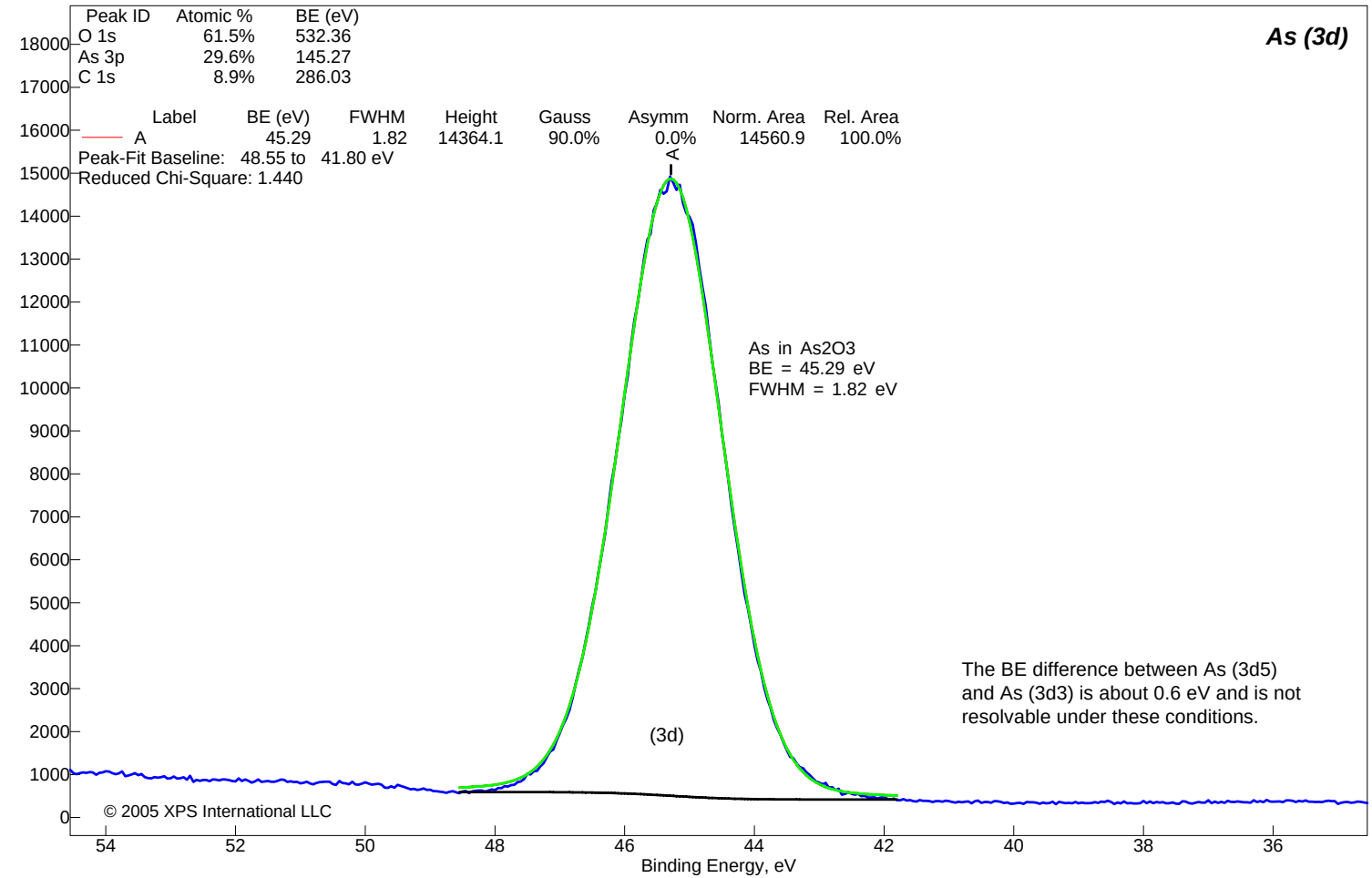


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

As_2O_3

Arsenic (III) Oxide (FW = 197.84)

Sample Description: As2O3 99.995% Aldr# 04445CW 3mm plt 90 TOA mesh

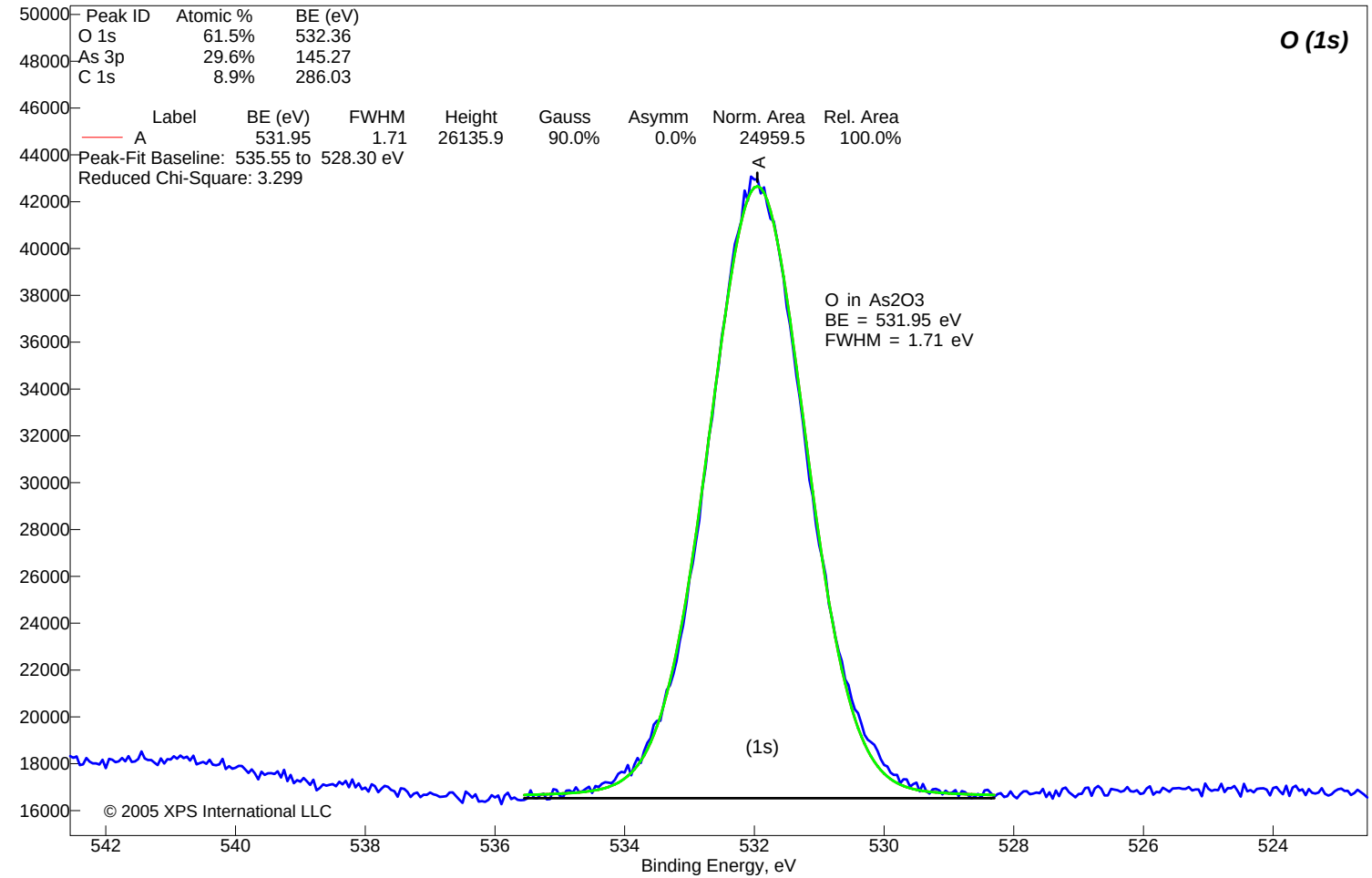


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

As_2O_3

Arsenic (III) Oxide (FW = 197.84)

Sample Description: As2O3 99.995% Aldrich Chem. Co. Lot# 04445CW
3mm pellet, 90 TOA, mesh

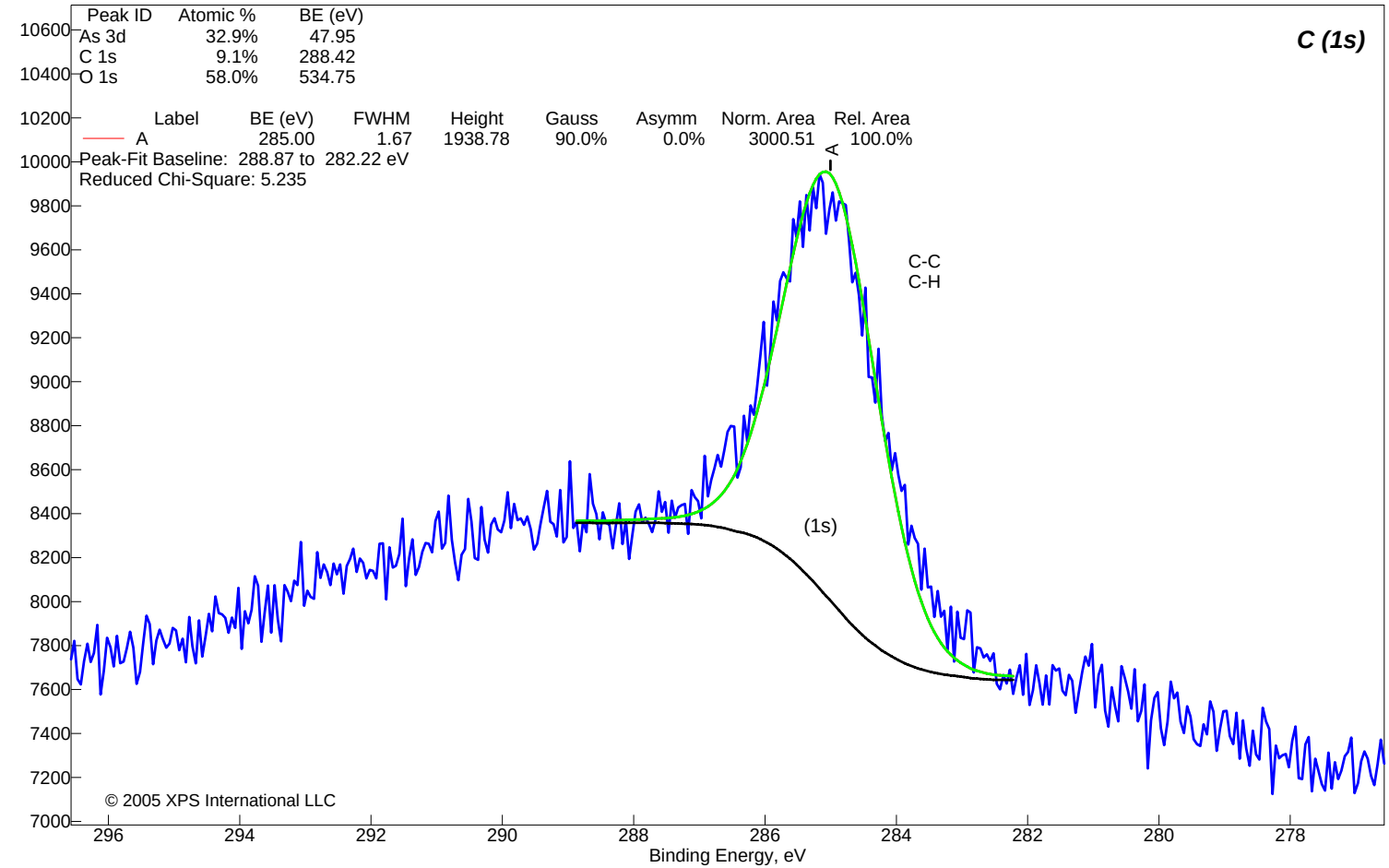


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

As_2O_3

Arsenic (III) Oxide (FW = 197.84)

Sample Description: As2O3 99.995% Aldr# 04445CW 3mm plt 90 TOA mesh

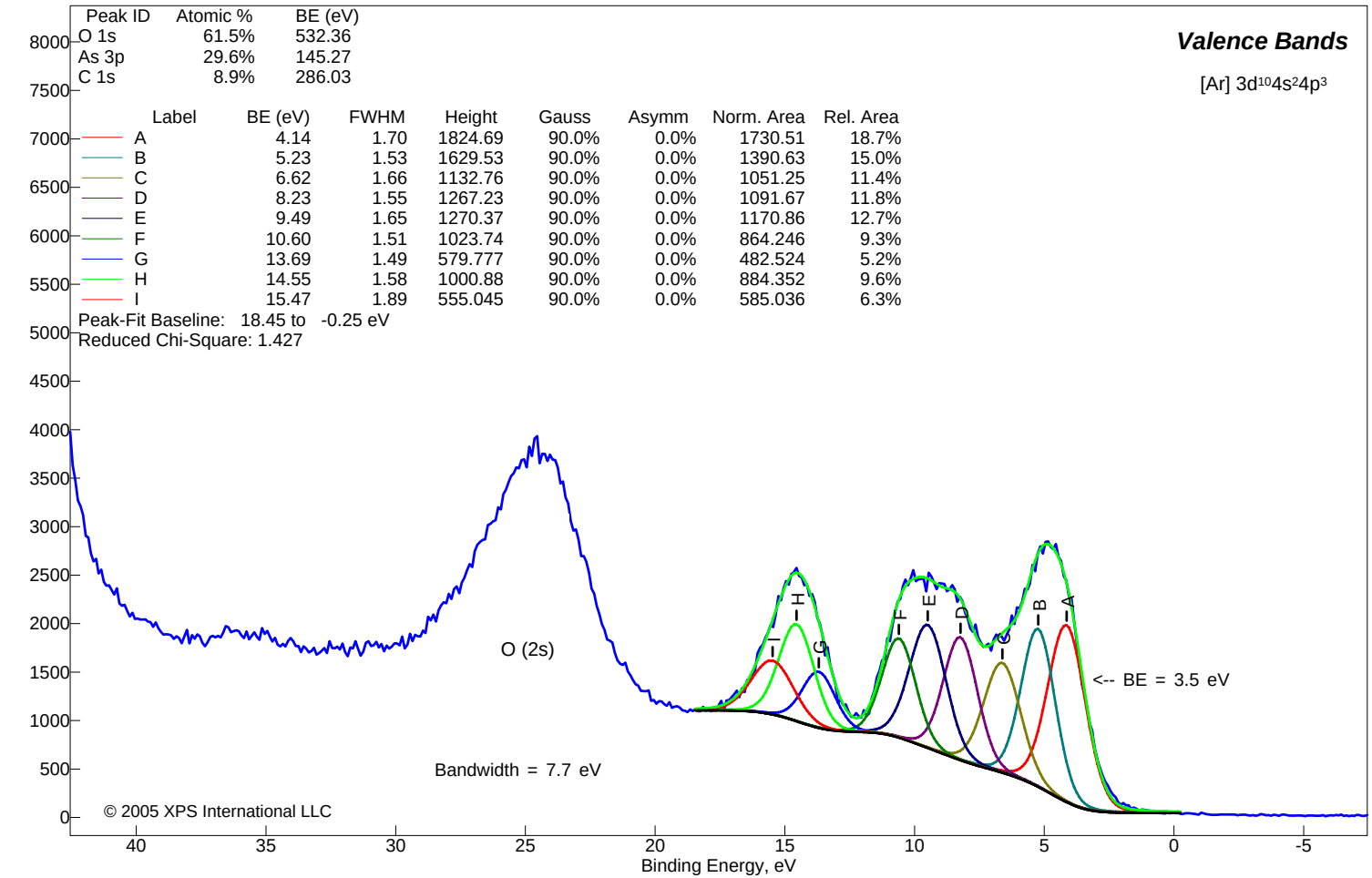


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

As_2O_3

Arsenic (III) Oxide (FW = 197.84)

Sample Description: As2O3 99.995% Aldr# 04445CW 3mm plt 90 TOA mesh

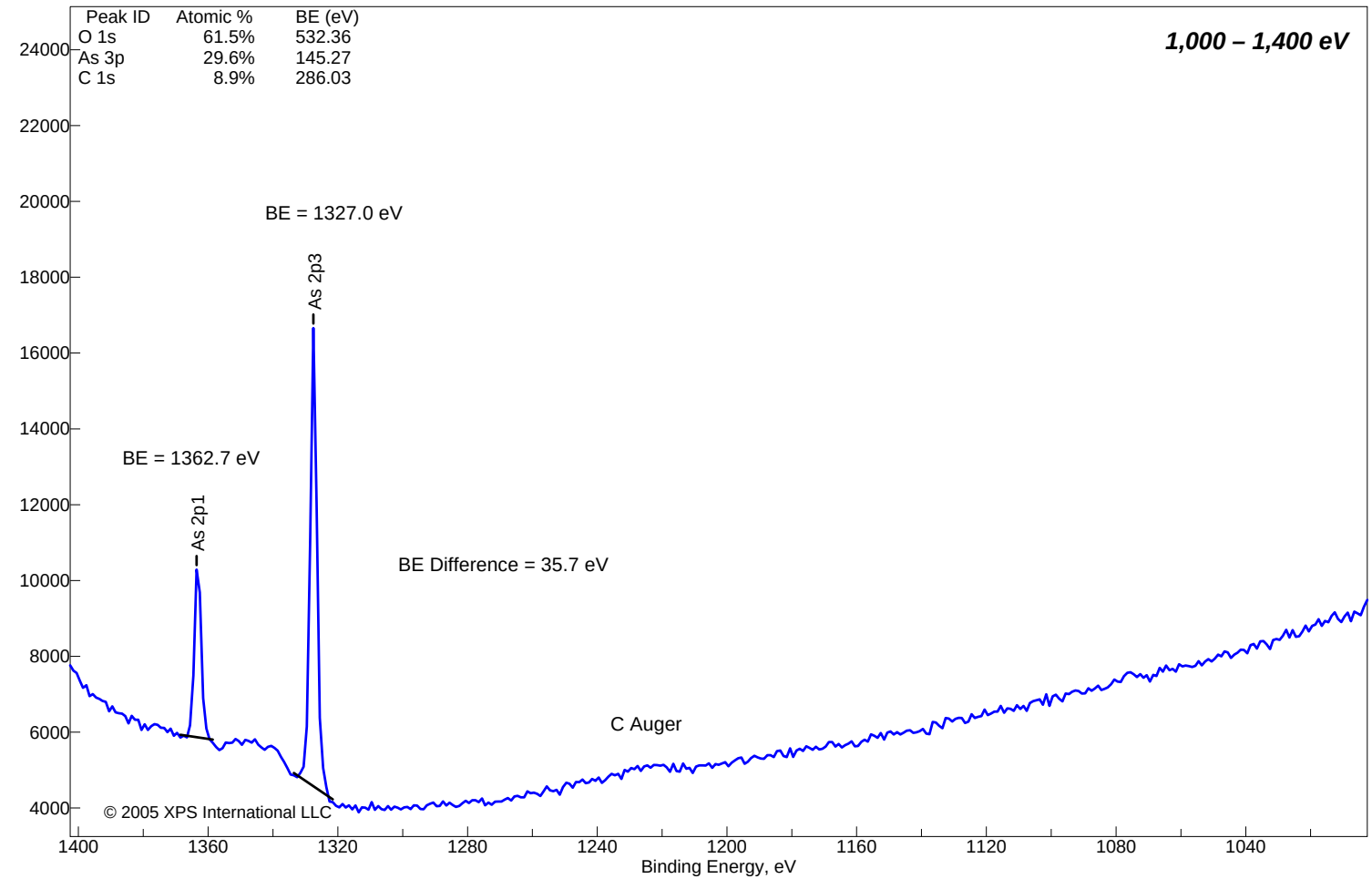


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Arsenic (III) Oxide (FW = 197.84)

Sample Description: As2O3 99.995% Aldr# 04445CW 3mm plt 90 TOA mesh

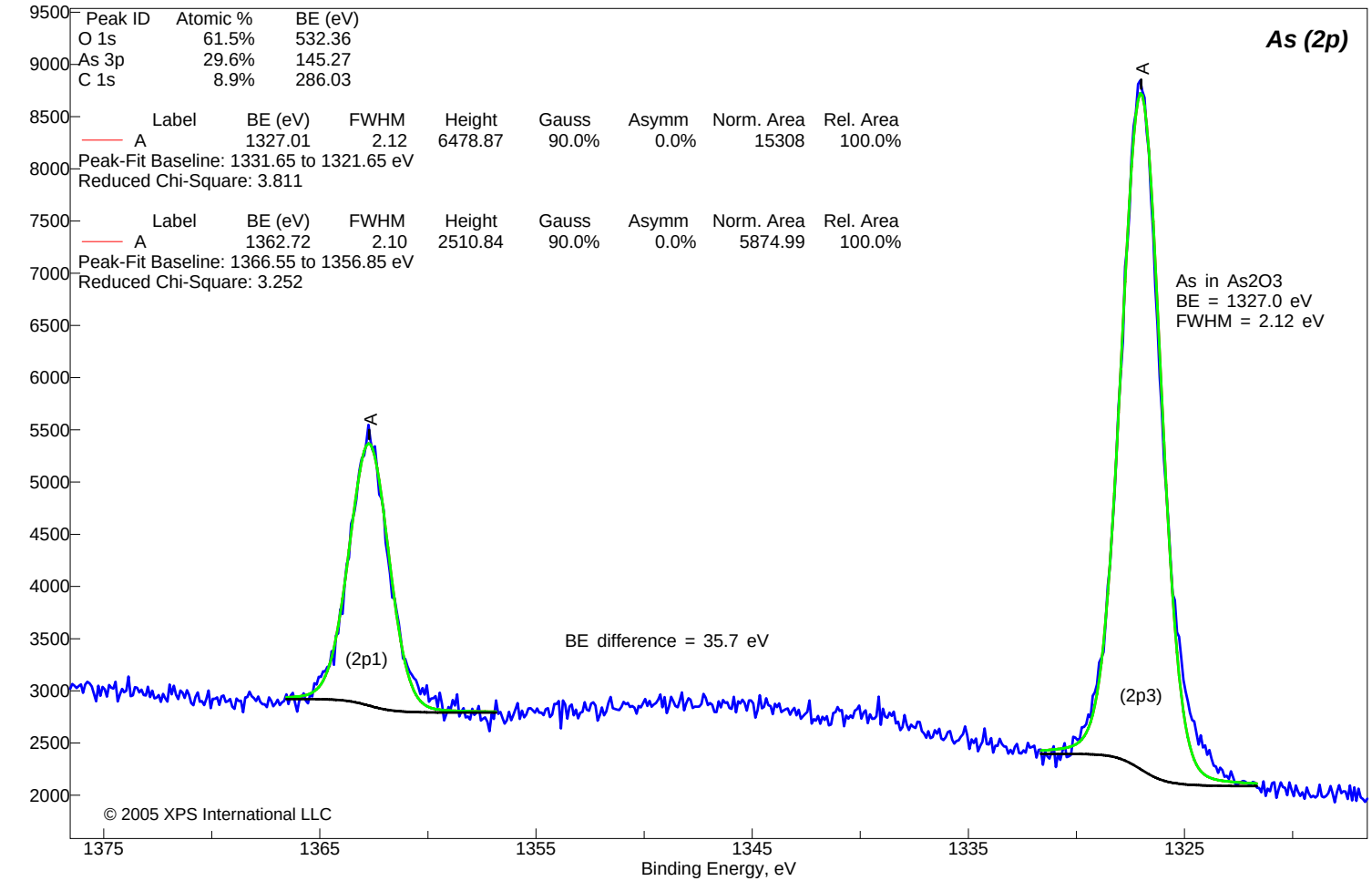


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

As_2O_3

Arsenic (III) Oxide (FW = 197.84)

Sample Description: As2O3 99.995% Aldr# 04445CW 3mm plt 90 TOA mesh

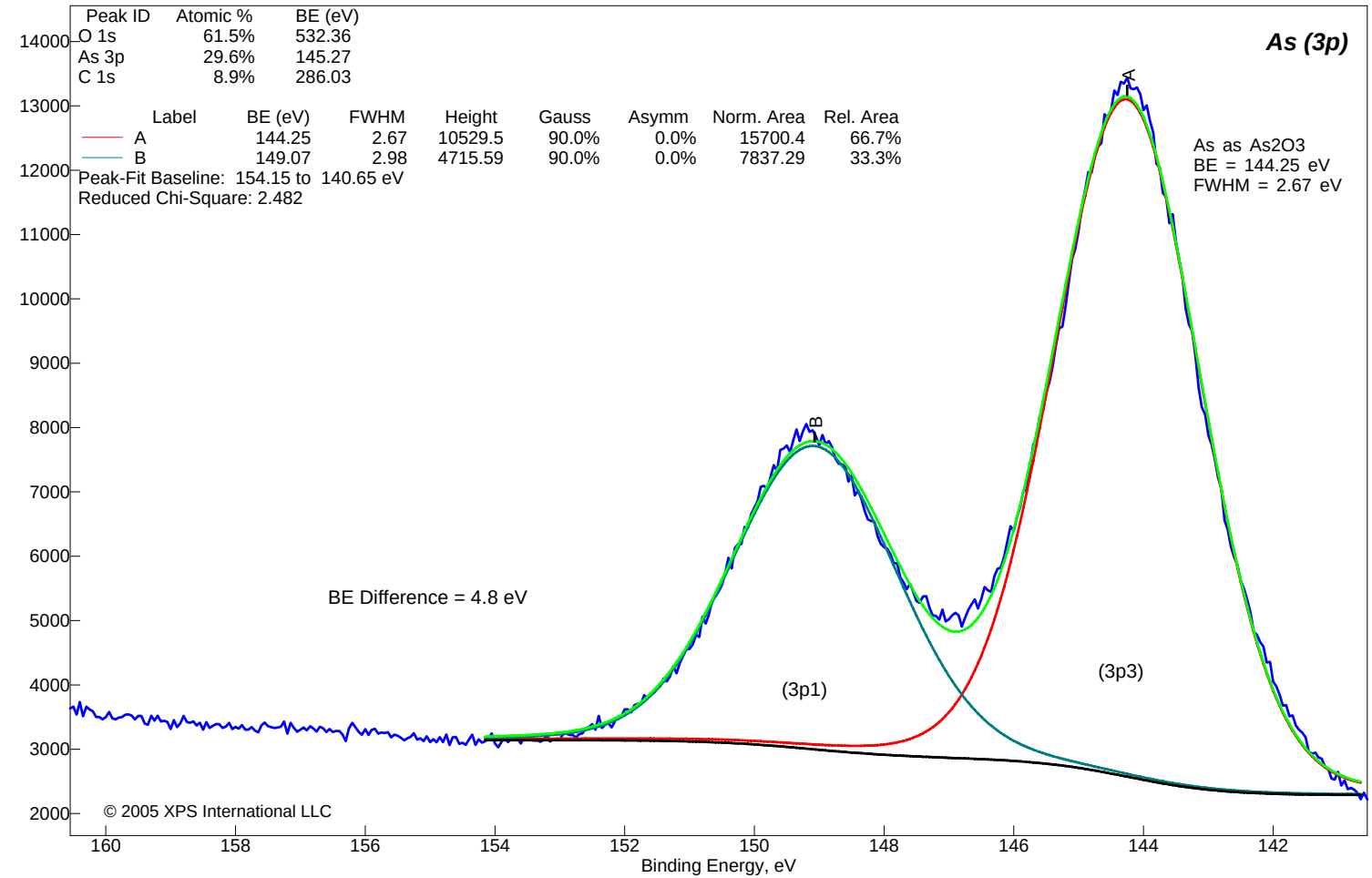


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Au_2O_3

Gold (III) Oxide (FW = 441.93)
Surface Composition Table

Description: Au_2O_3 (Au 86%) from Aldrich Lot# 00306AW, analyzed at 90 deg TOA, mesh at 1mm, semi-conductive brown powder, pressed into 3 mm pellet, mp 150 C dec., sol in HCl, HNO_3

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
O 2s	22.6	22.6	0.14	1.5	15,712	
Au 5p3	59.7	59.7	1.10	1.5	17,360	
Au 4f	87.0	87.0	17.12	1.1	68,640	10.7%
Au loss	113.5	113.5	0.00	1.5	42,102	
Pb 4f	138.9	138.9	22.74	1.5	58,144	3.3%
Cl 2p	199.5	199.5	2.28	1.5	11,661	7.1%
Cl 2s	270.9	270.9	1.69	1.5	8,850	
C 1s	285.5	285.5	1.00	1.5	24,448	37.5%
Au 4d5	338.3	338.3	11.74	1.5	137,776	
Au 4d3	355.9	355.9	8.06	1.5	115,235	
Pb 4d5	414.5	414.5	13.02	1.5	20,249	
Pb 4d3	436.1	436.1	8.87	1.5	15,737	
Na Auger	496.7	496.7	0.00	1.5	5,574	
O 1s	531.8	531.8	2.93	1.5	56,013	41.4%
Au 4p3	549.4	549.4	5.89	1.5	72,433	
Au 4p1	645.2	645.2	2.14	1.5	25,057	
Au 4s	765.5	765.5	1.92	1.5	12,209	
O Auger	973.7	973.7	0.00	1.5	11,355	

Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Gold (III) Oxide (FW = 441.93)

Sample Description: Au2O3 (Au 86%) from Aldrich Lot# 00306AW, Semi-Conductive
pressed into 3 mm pellet, analyzed at 90 deg TOA, mesh-screen at 1 mm height

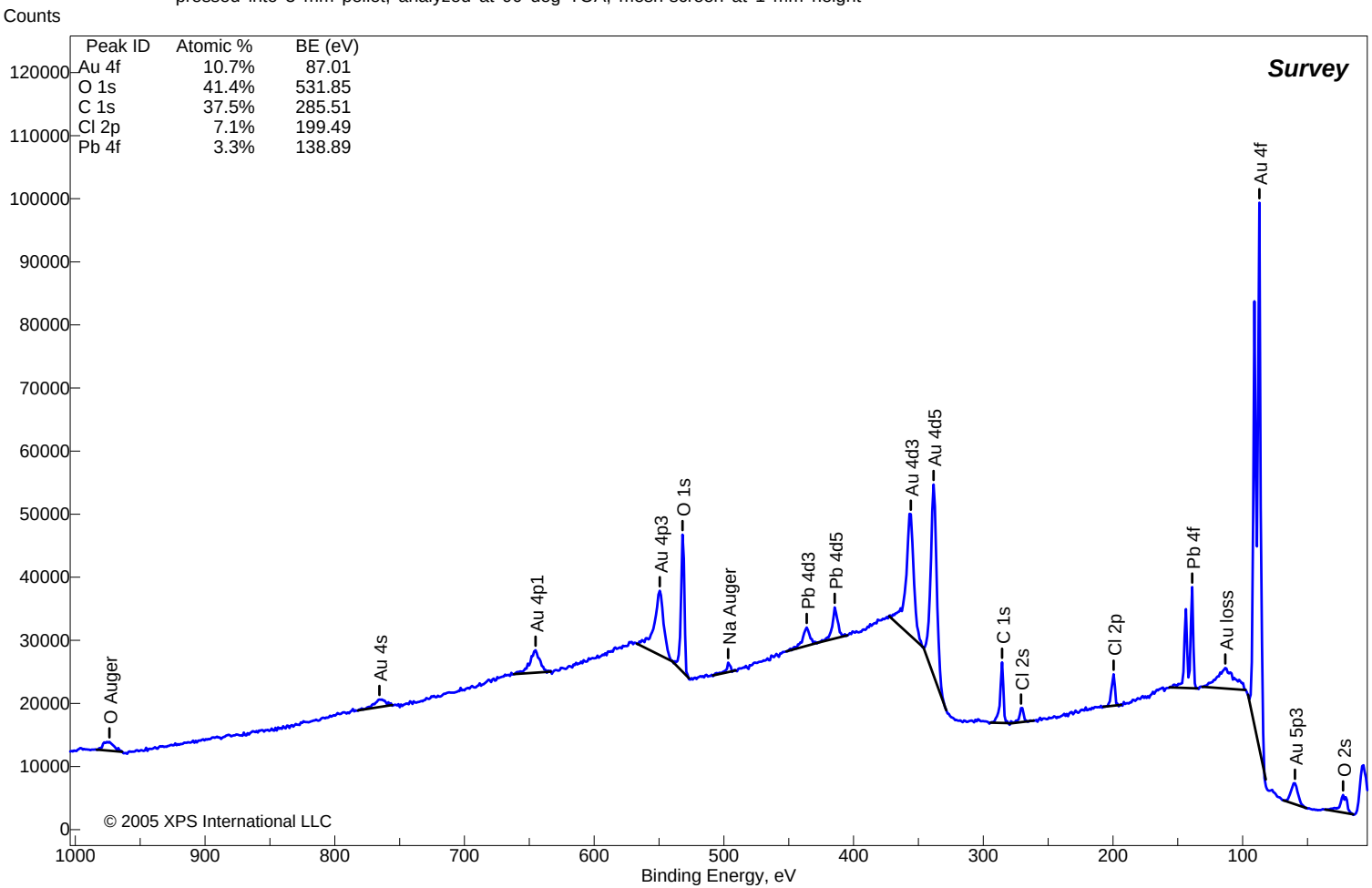


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Gold (III) Oxide (FW = 441.93)

Sample Description: Au2O3 (Au 86%) Aldr 00306AW, 3 mm pellet, 90 TOA, Semi-Conductive

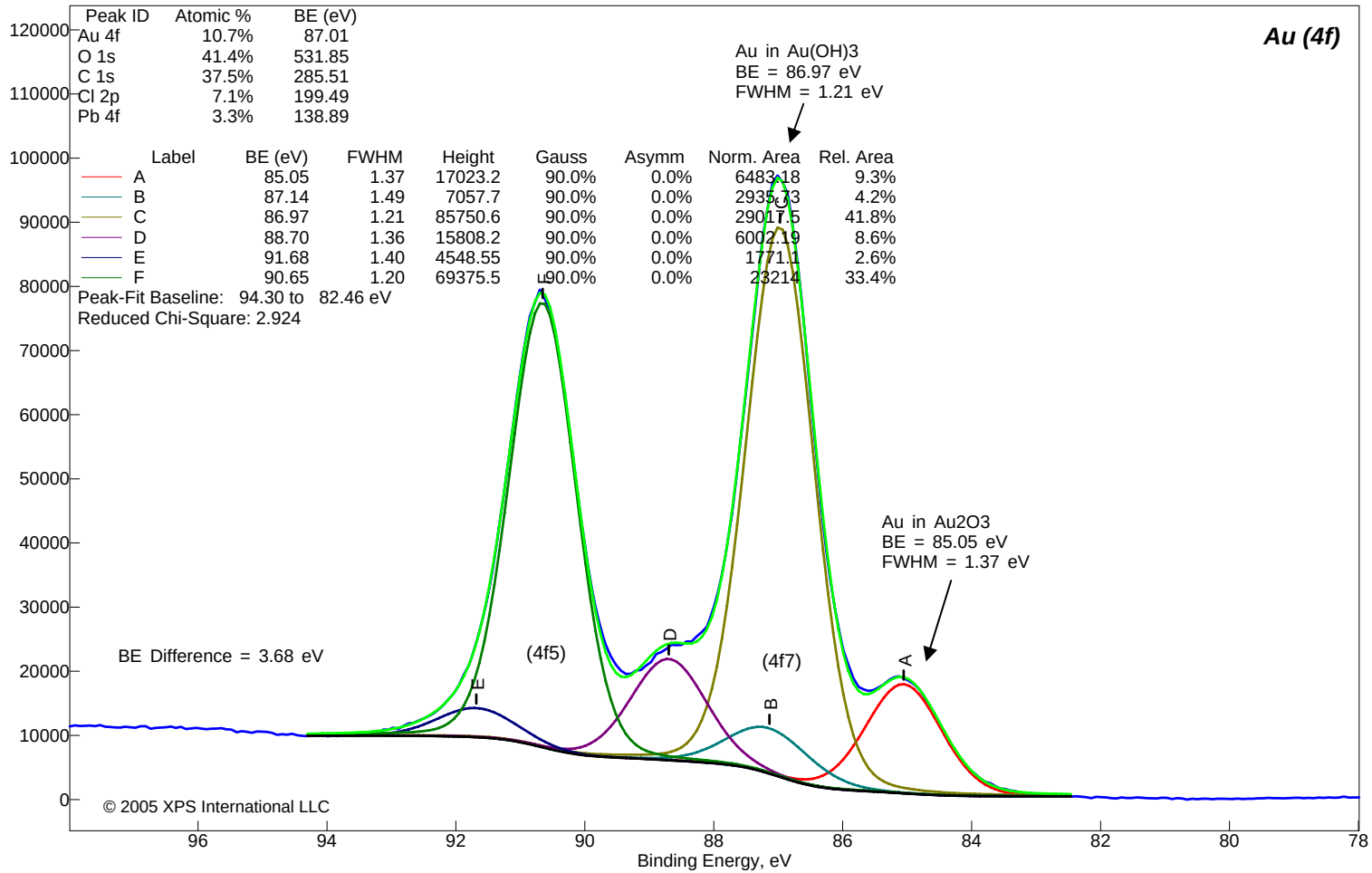


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Gold (III) Oxide (FW = 441.93)

Sample Description: Au2O3 (Au 86%) Aldr 00306AW, 3 mm pellet, 90 TOA, Semi-Conductive

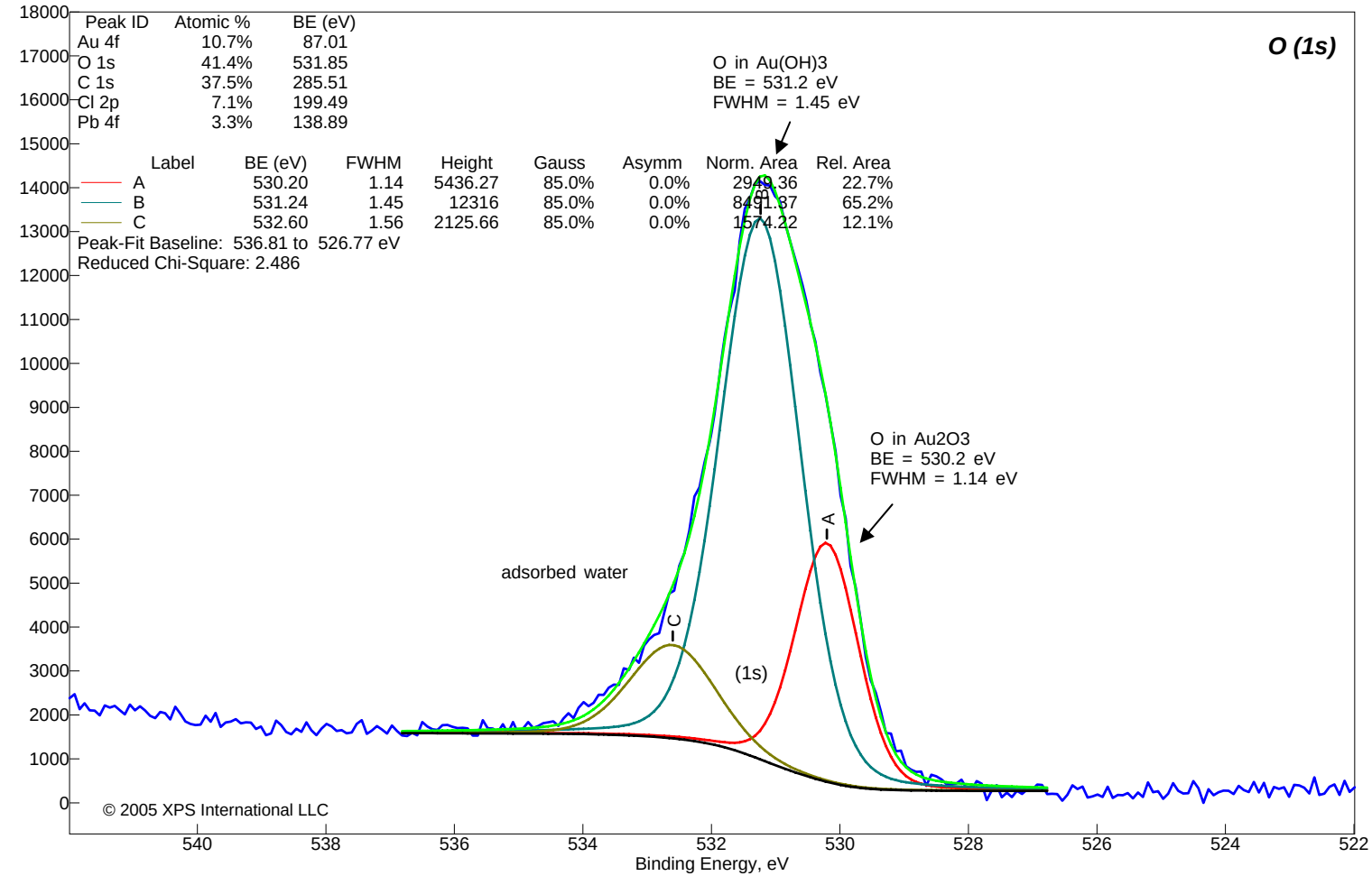


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Gold (III) Oxide (FW = 441.93)

Sample Description: Au2O3 (Au 86%) Aldr 00306AW, 3 mm pellet, 90 TOA, Semi-Conductive

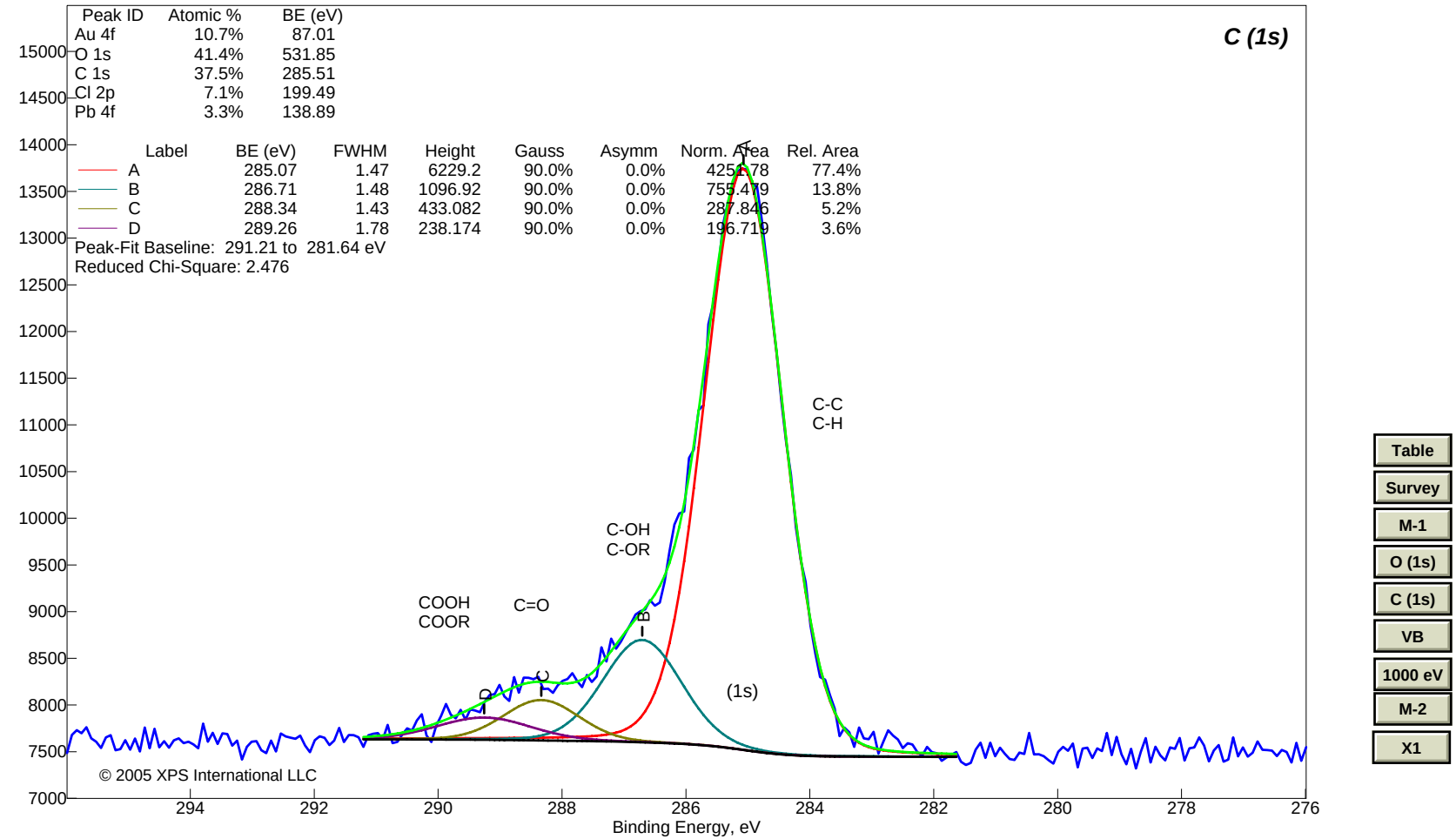


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Gold (III) Oxide (FW = 441.93)

Sample Description: Au2O3 (Au 86%) Aldr 00306AW, 3 mm pellet, 90 TOA, Semi-Conductive

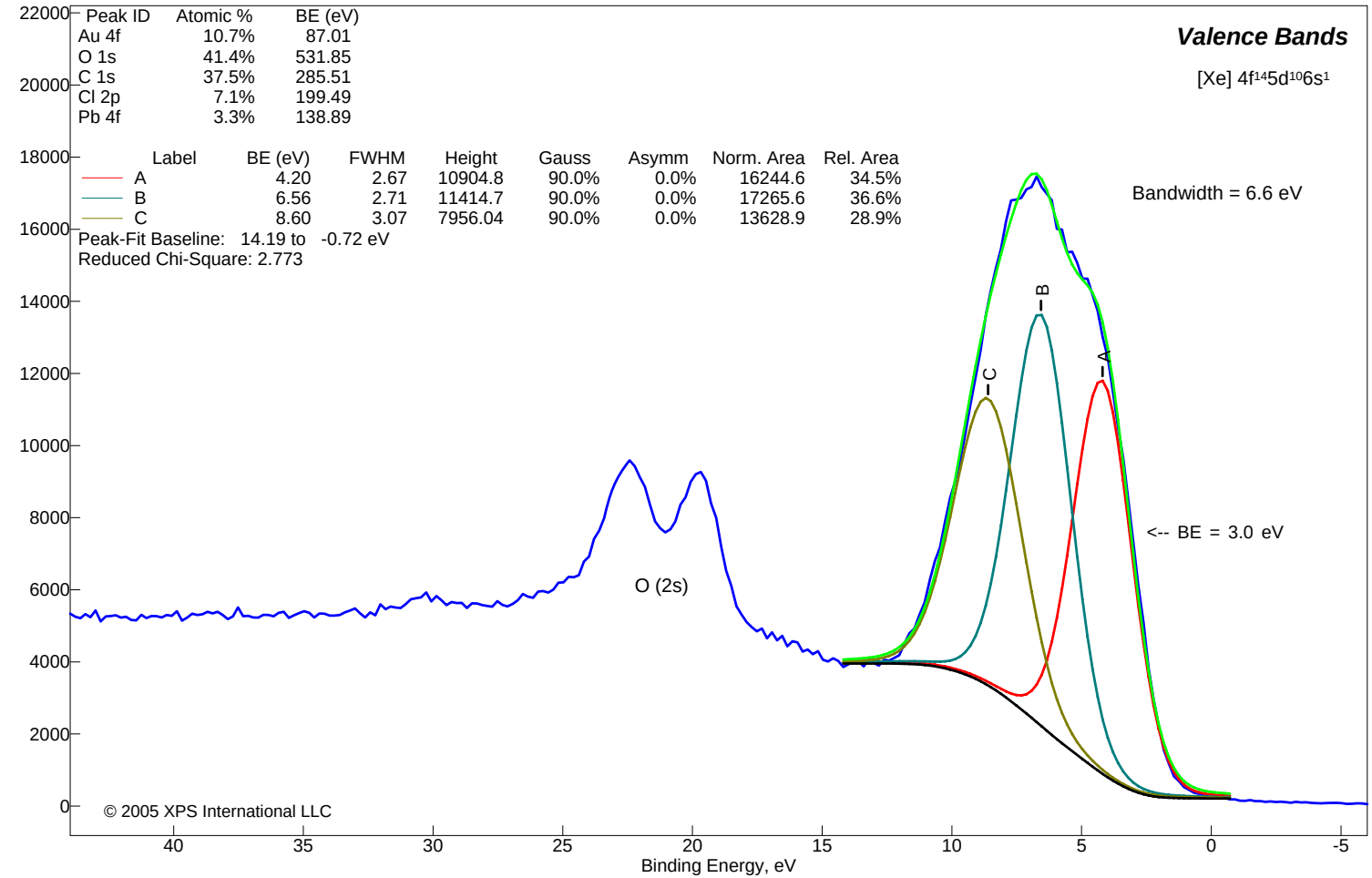


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Au_2O_3

Gold (III) Oxide (FW = 441.93)

Sample Description: Au2O3 (Au 86%) Aldr 00306AW, 3 mm pellet, 90 TOA, Semi-Conductive

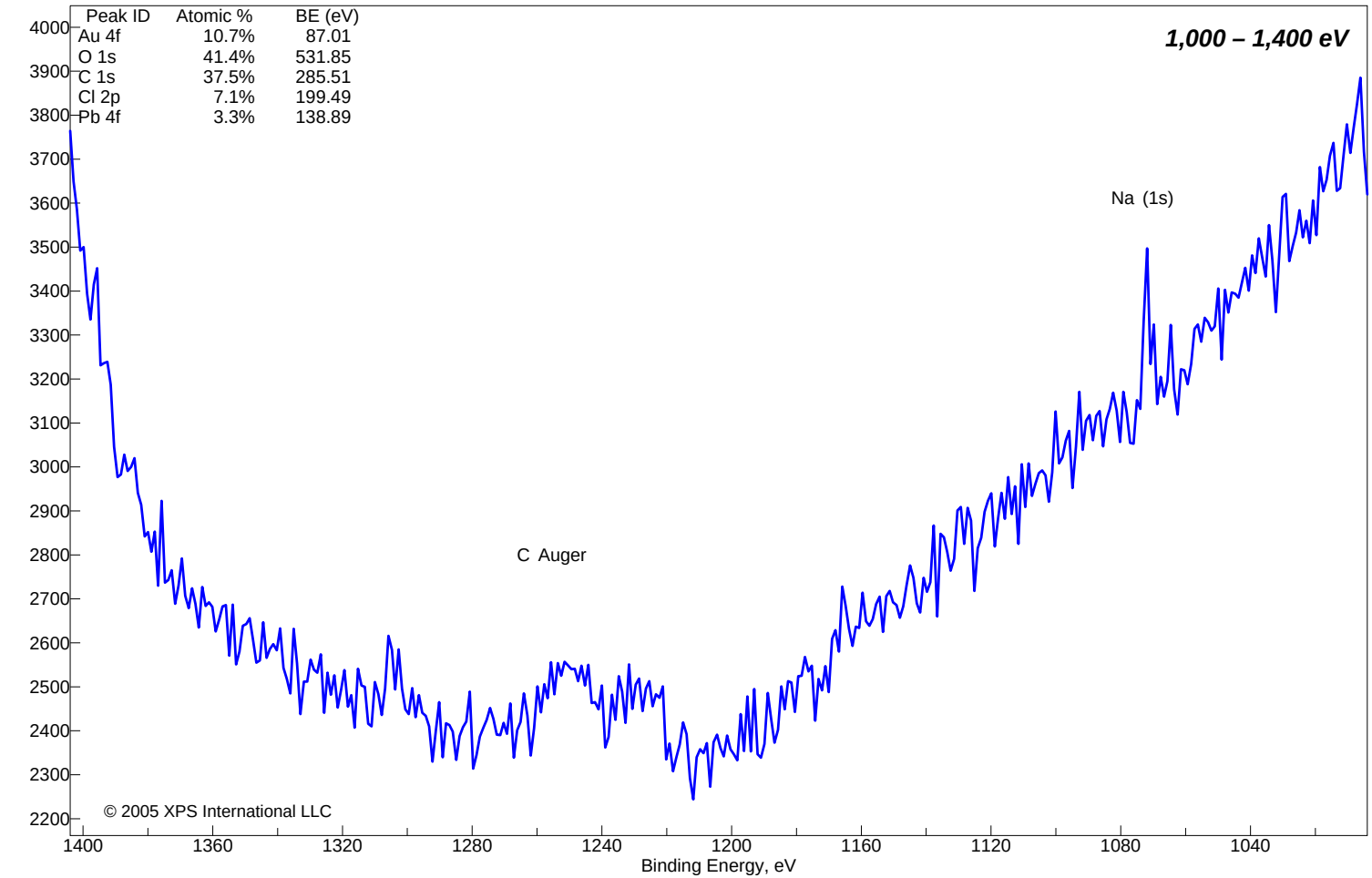


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Au_2O_3

Gold (III) Oxide (FW = 441.93)

Sample Description: Au2O3 (Au 86%) Aldr 00306AW, 3 mm pellet, 90 TOA, Semi-Conductive

Counts

Peak ID	Atomic %	BE (eV)
Au 4f	10.7%	87.01
O 1s	41.4%	531.85
C 1s	37.5%	285.51
Cl 2p	7.1%	199.49
Pb 4f	3.3%	138.89

Label	BE (eV)	FWHM	Height	Gauss	Asymm	Norm. Area	Rel. Area
A	334.09	4.41	1767.03	85.0%	0.0%	4442.53	13.2%
B	337.69	4.32	11829.4	85.0%	0.0%	29161	86.8%

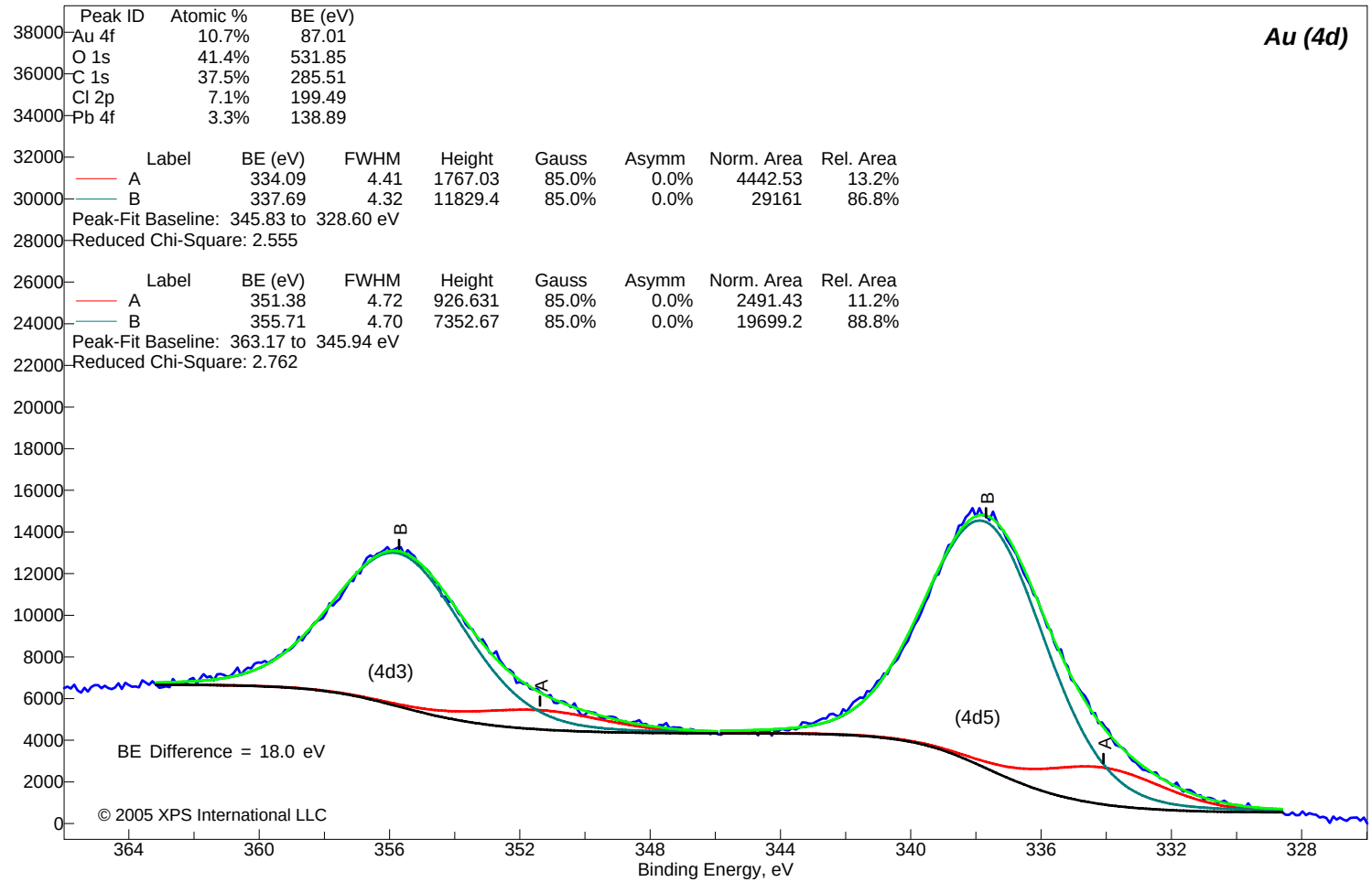
Peak-Fit Baseline: 345.83 to 328.60 eV

Reduced Chi-Square: 2.555

Label	BE (eV)	FWHM	Height	Gauss	Asymm	Norm. Area	Rel. Area
A	351.38	4.72	926.631	85.0%	0.0%	2491.43	11.2%
B	355.71	4.70	7352.67	85.0%	0.0%	19699.2	88.8%

Peak-Fit Baseline: 363.17 to 345.94 eV

Reduced Chi-Square: 2.762



Table

Survey

M-1

O (1s)

C (1s)

VB

1000 eV

M-2

X1

Gold (III) Oxide (FW = 441.93)

Sample Description: Au2O3 (Au 86%) Aldr 00306AW, 3 mm pellet, 90 TOA, Semi-Conductive

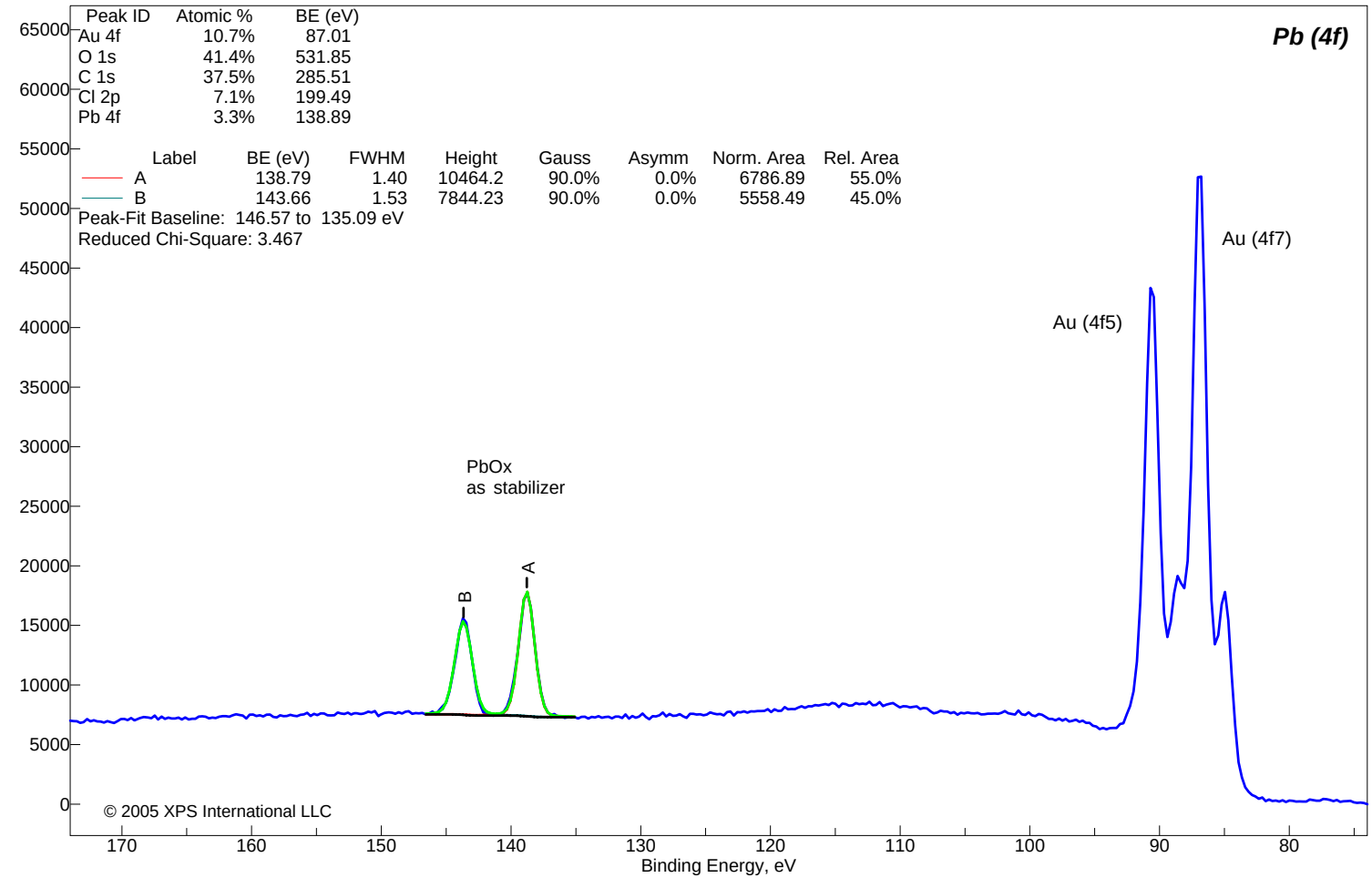


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

B_2O_3

Boron (III) Oxide (FW = 69.62)
Surface Composition Table

Description: B_2O_3 (99.999%) from Aldrich Lot# 02829BV, analyzed at 90 deg TOA, mesh at 1mm, non-conductive white pieces, bulk freshly exposed, mp 450 C, d. 2.46, sol in boiling water

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
O 2s	27.1	23.6	0.14	1.5	8,540	
B 1s	194.2	190.7	0.49	1.5	22,156	28.0%
B loss	216.7	213.2	0.00	1.5	2,580	
C 1s	285.1	281.6	1.00	1.5	28,994	19.9%
C loss	304.7	301.2	0.00	1.5	7,042	
N 1s	402.4	398.9	1.80	1.5	2,184	1.0%
O 1s	533.4	529.9	2.93	1.5	154,657	51.2%
O loss	554.9	551.4	0.00	1.5	79,553	
O KLL-1	980.1	976.6	0.70	1.5	26,712	

Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV

Y_2O_3

Yttrium (III) Oxide (FW = 225.82)
Surface Composition Table

Description: Y_2O_3 (99.9%) from Rare Metallics Co. Lot# 71208-13, analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white powder pressed into 3 mm pellet, mp 2410 C, d 5.01, sol in acid

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
Y 4p	25.0	23.5	0.09	1.5	31,860	
Y 4s	44.5	43.0	0.33	1.5	13,470	
Y loss	60.2	58.7	0.00	1.5	5,254	
Y 3d	156.9	155.4	5.98	1.5	157,934	
Y loss	170.6	169.1	0.00	1.5	49,940	
Y loss	194.1	192.6	0.00	1.5	11,080	
C 1s	285.0	283.5	1.00	1.5	60,093	43.8%
Y 3p3	299.7	298.2	4.75	1.5	97,698	15.3%
Y 3p1	311.4	309.9	2.44	1.5	62,179	
Y loss	323.1	321.6	0.00	1.5	4,734	
Y loss	334.8	333.3	0.00	1.5	4,192	
Y loss	349.5	348.0	0.00	1.5	2,629	
Y 3s	394.5	393.0	1.98	1.5	24,800	
Y loss	408.2	406.7	0.00	1.5	1,467	
Y loss	430.6	429.1	0.00	1.5	206	
O 1s	531.3	529.8	2.93	1.5	116,257	40.9%
O loss	548.9	547.4	0.00	1.5	13,536	
O loss	565.5	564.0	0.00	1.5	3,781	
O KLL-1	974.1	972.6	0.70	1.5	16,626	
O Auger	994.7	993.2	0.00	1.5	3,389	

Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Y_2O_3

Yttrium (III) Oxide (FW = 225.82)

Sample Description: Y2O3 (99.9%) from Rare Metallics Corp. lot# 71208-13
pressed into 3 mm pellet, analyzed at 90 deg TOA, mesh-screen at 1 mm height

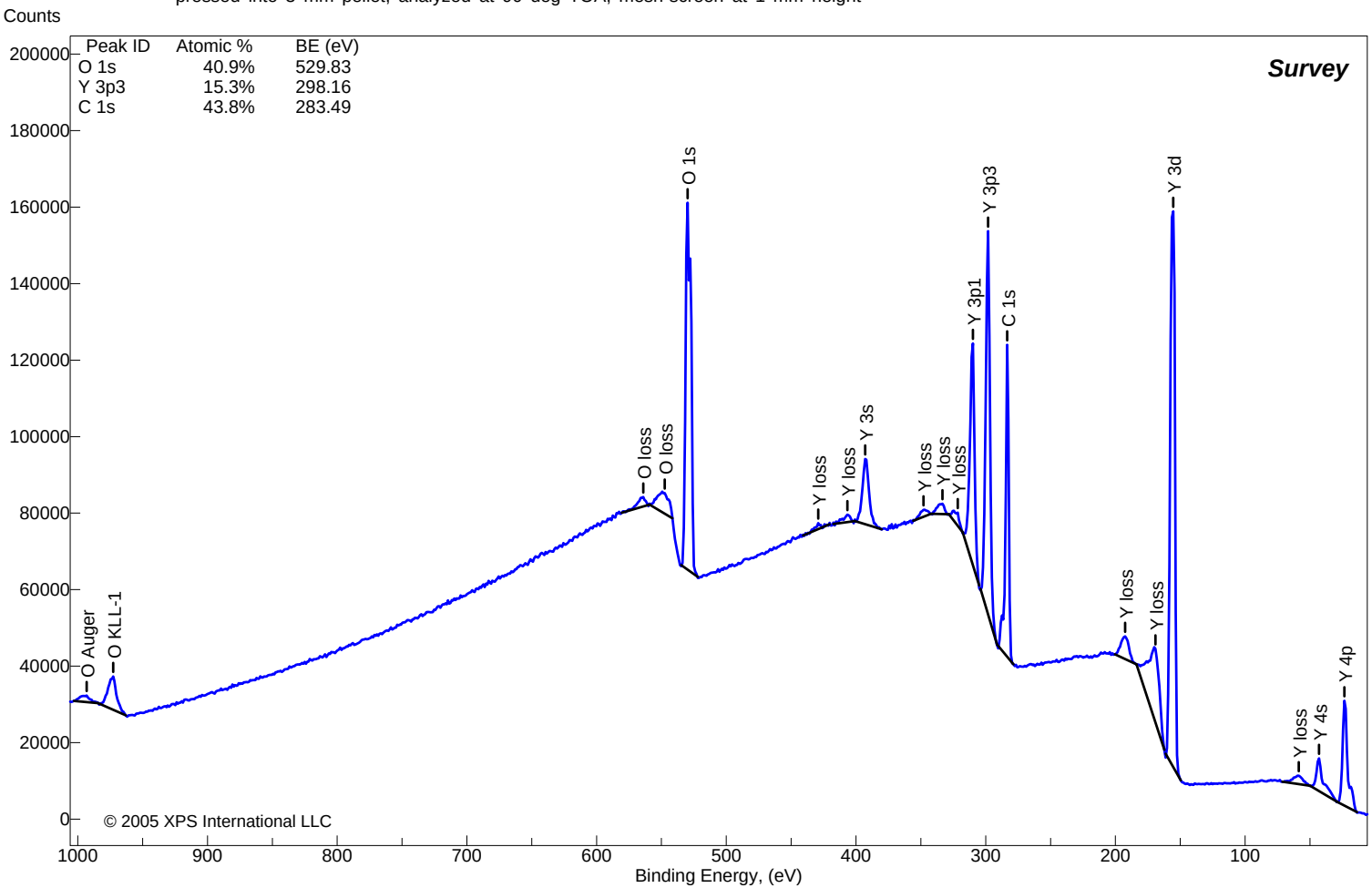


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Yttrium (III) Oxide (FW = 225.82)

Sample Description: Y2O3 (99.9%) RMC #71208-13 (exposed to air), screen, 90 TOA

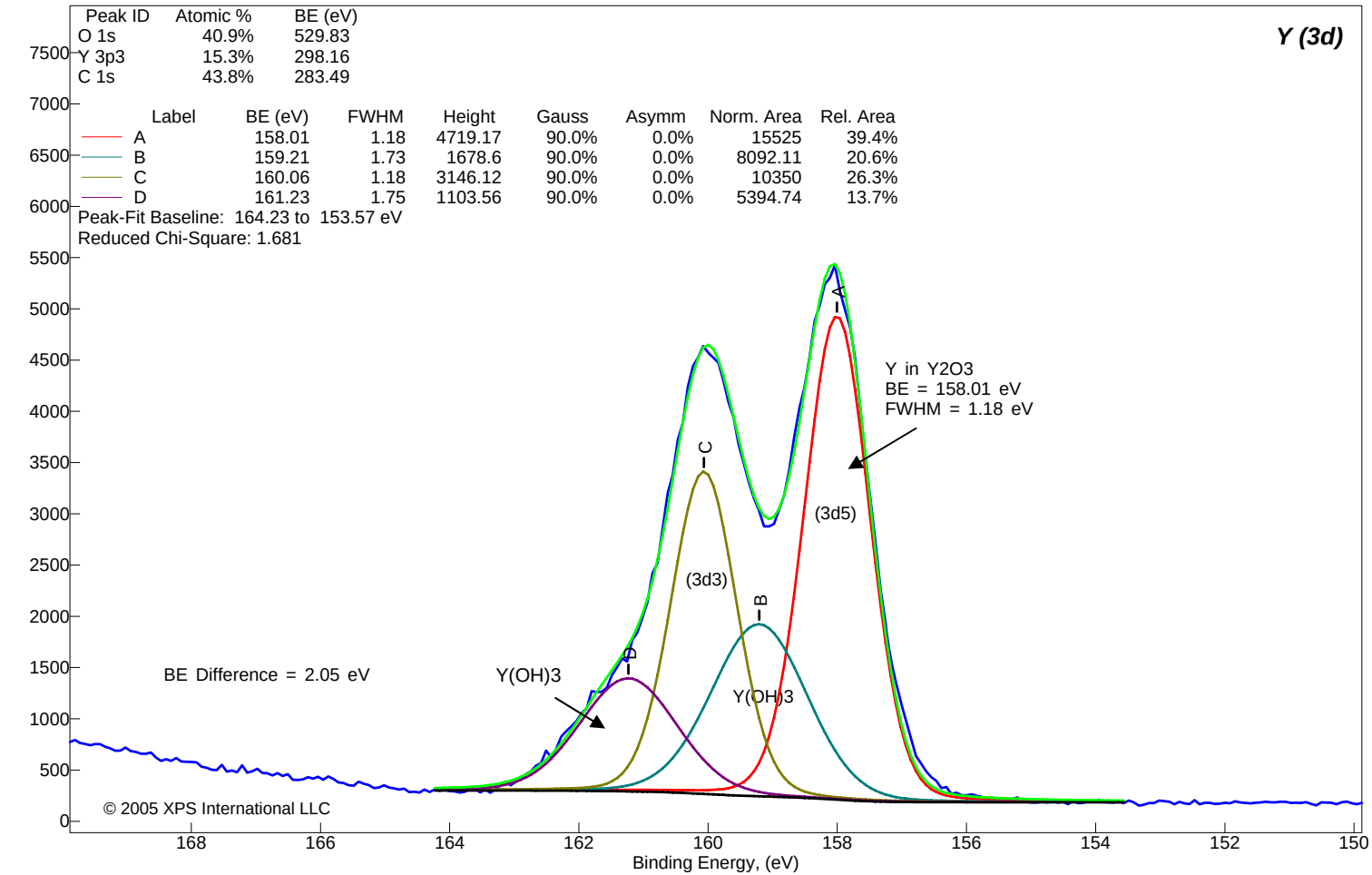


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Yttrium (III) Oxide (FW = 225.82)

Sample Description: Y2O3 (99.9%) RMC #71208-13 (exposed to air), screen, 90 TOA

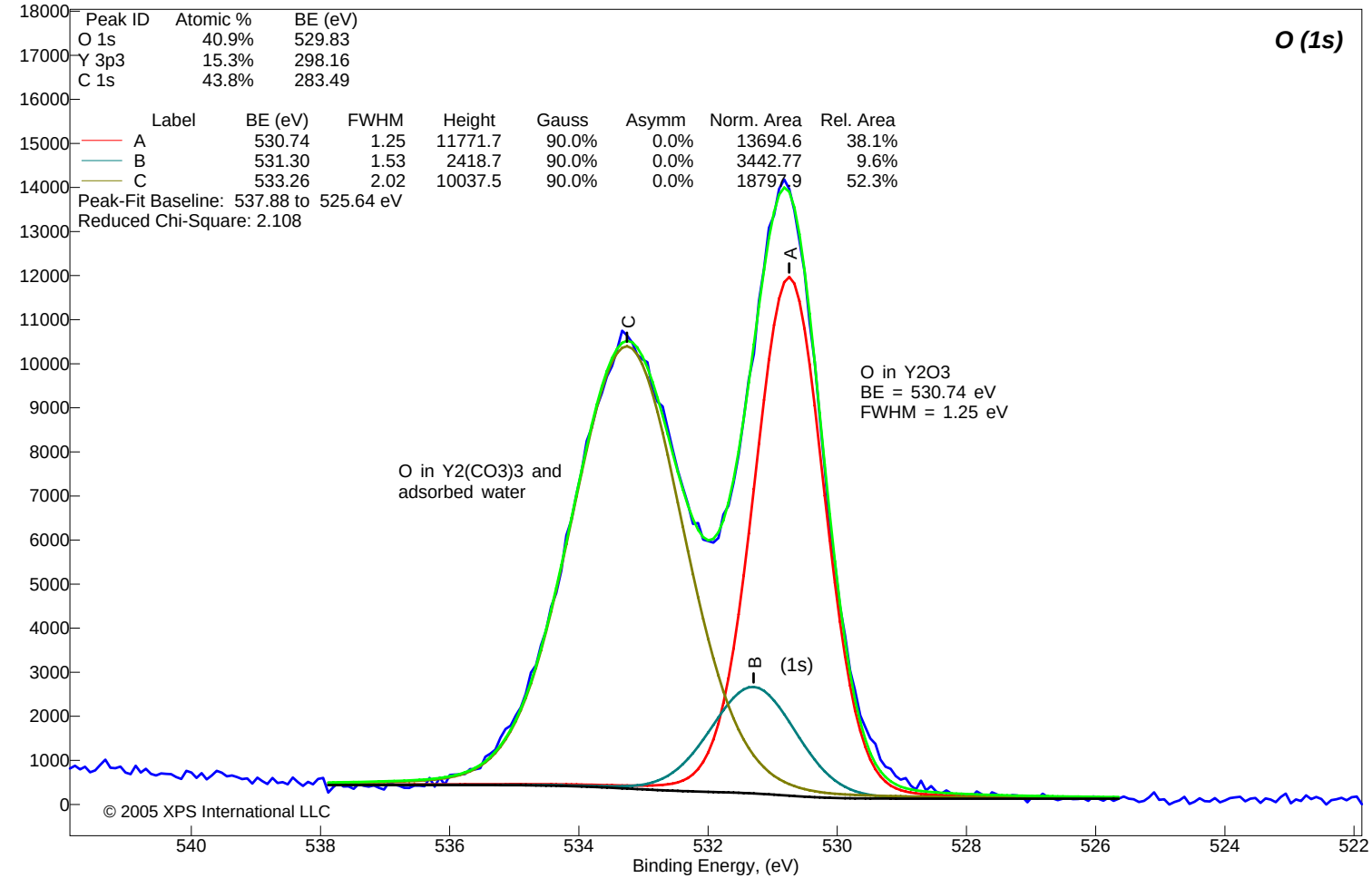


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Y_2O_3

Yttrium (III) Oxide (FW = 225.82)

Sample Description: Y2O3 (99.9%) RMC #71208-13 (exposed to air), screen, 90 TOA

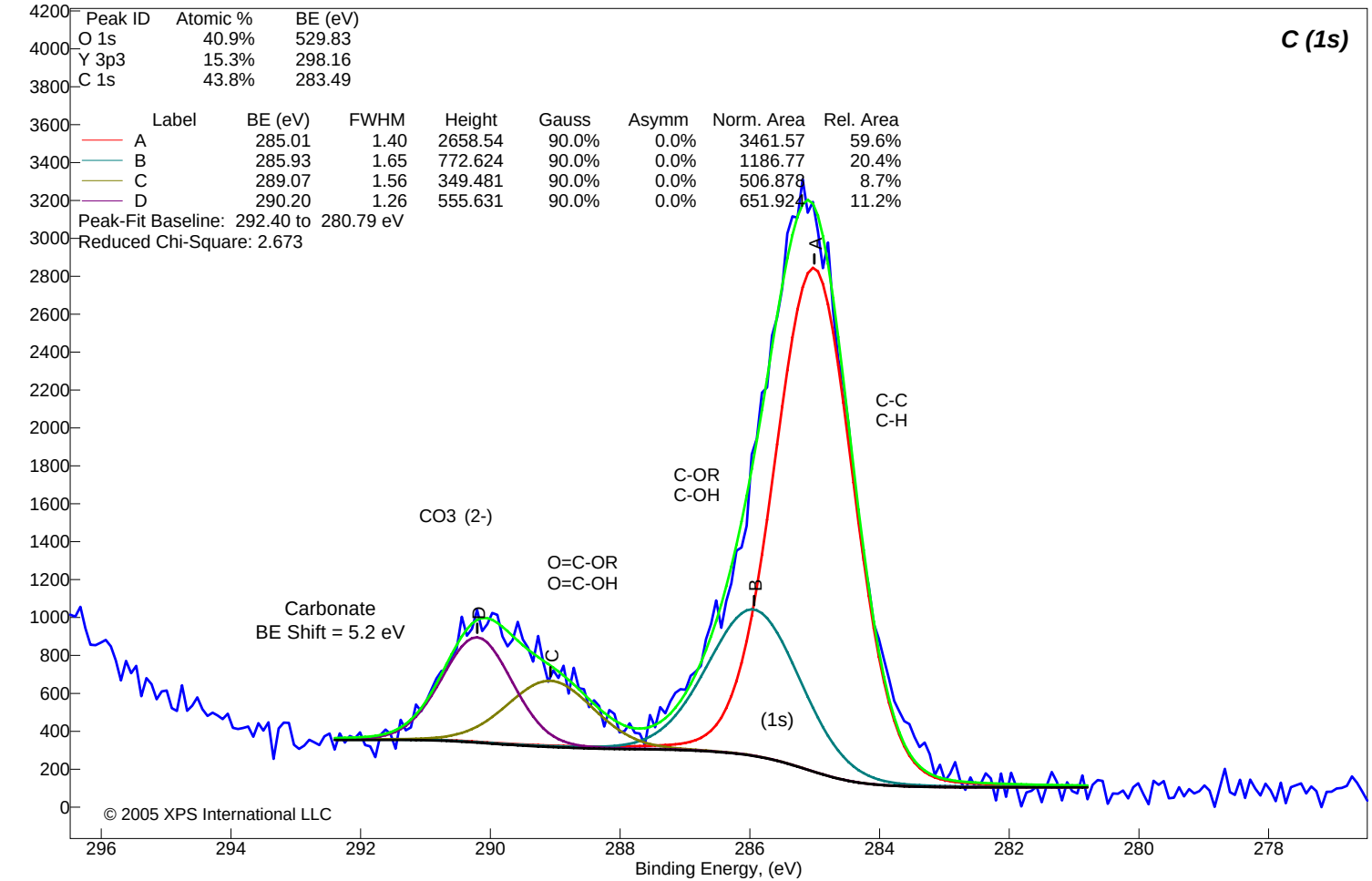


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Y_2O_3

Yttrium (III) Oxide (FW = 225.82)

Sample Description: Y2O3 (99.9%) RMC #71208-13 (exposed to air), screen, 90 TOA

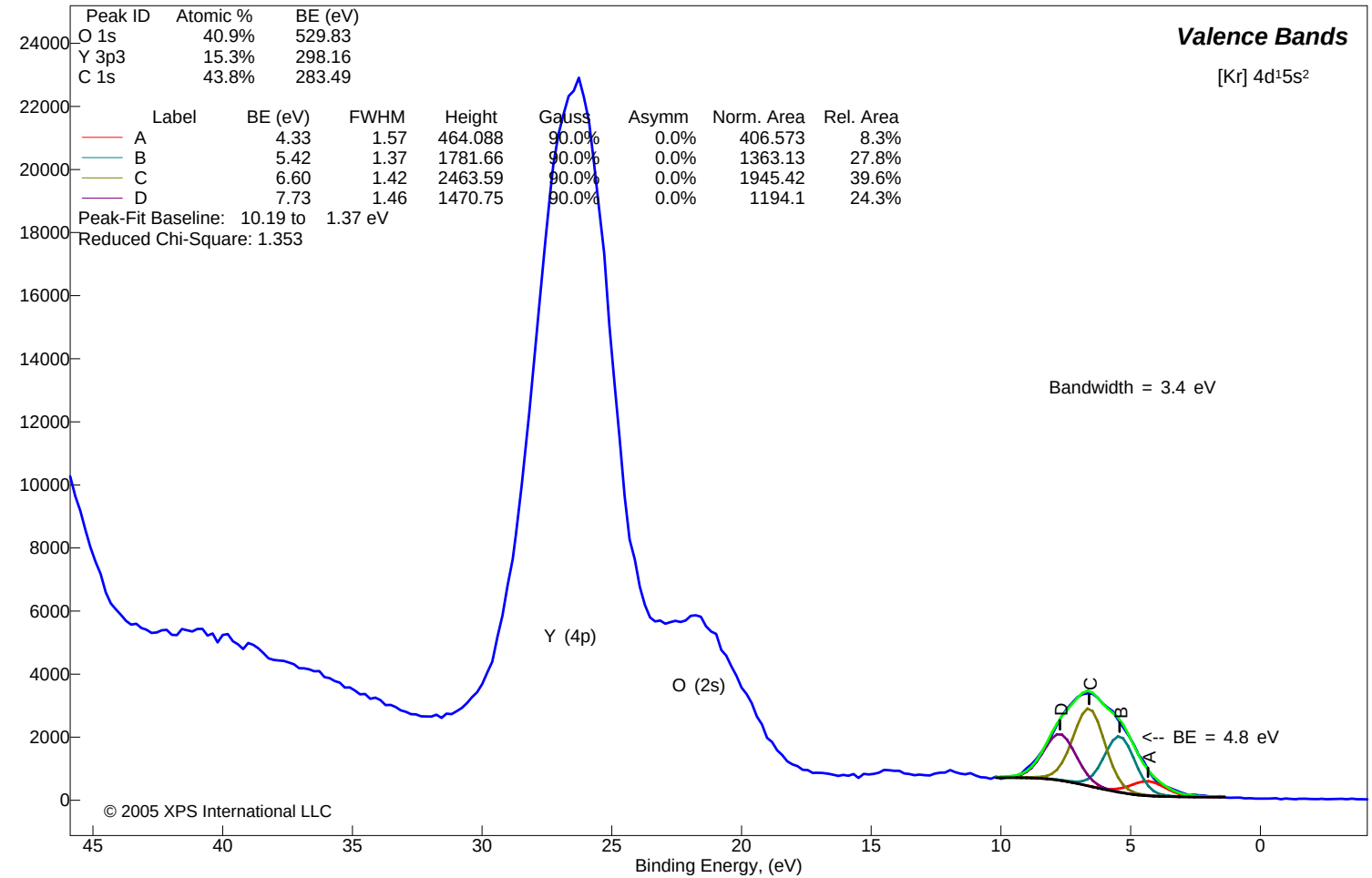


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Y_2O_3

Yttrium (III) Oxide (FW = 225.82)

Sample Description: Y2O3 (99.9%) RMC #71208-13 (exposed to air), screen, 90 TOA

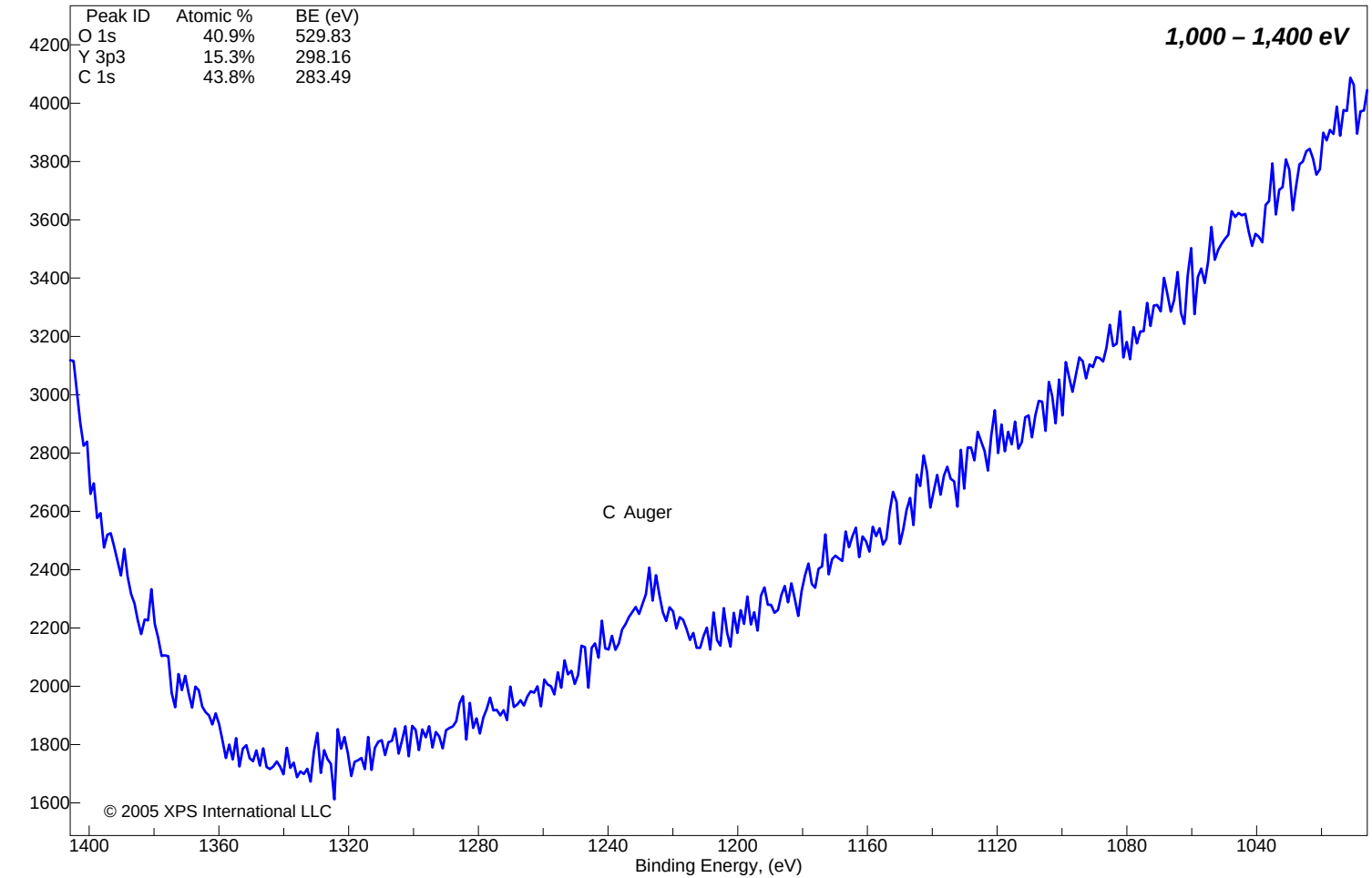


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Yttrium (III) Oxide (FW = 225.82)

Sample Description: Y2O3 (99.9%) RMC #71208-13 (exposed to air), screen, 90 TOA

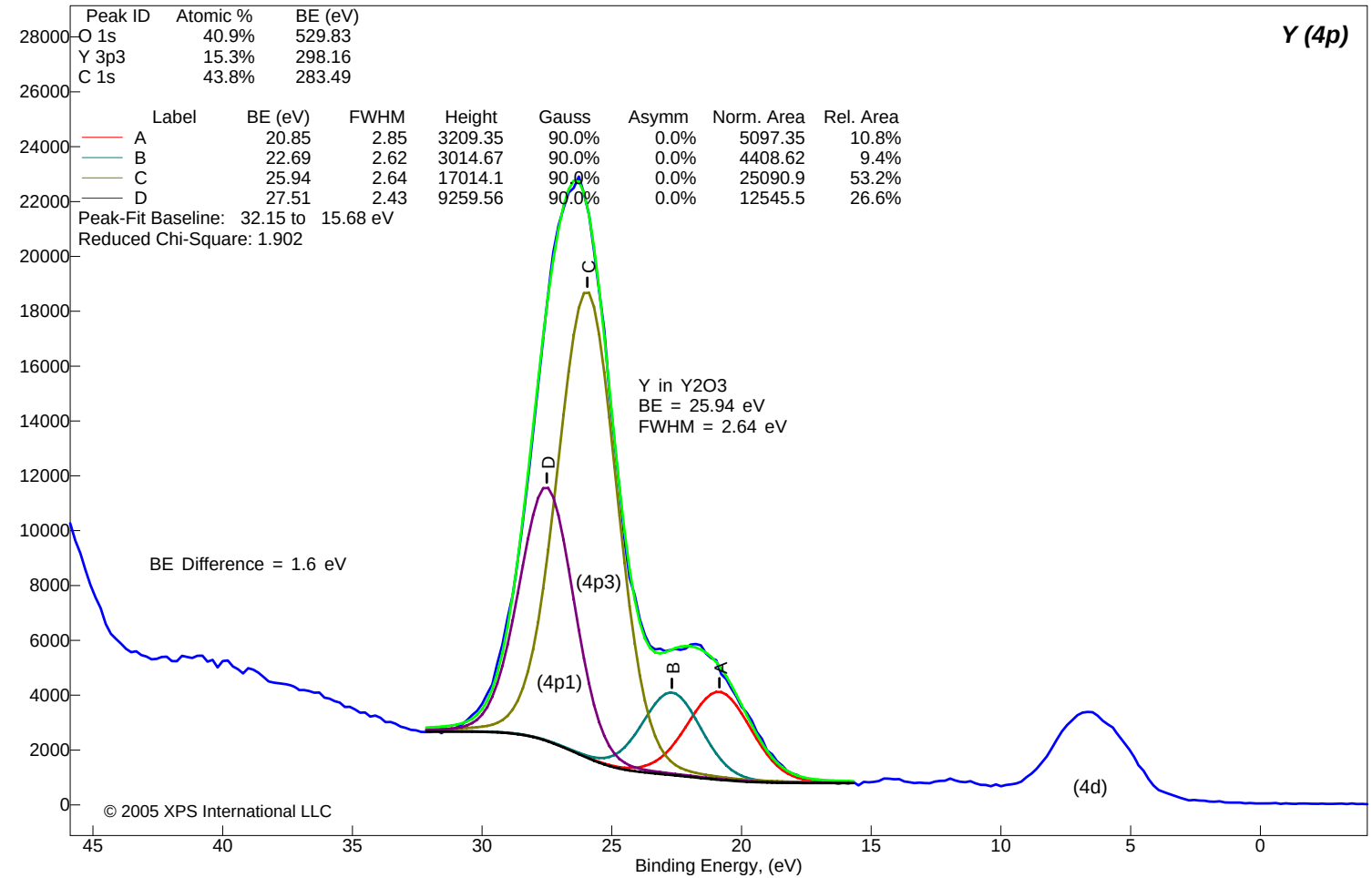


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

Y_2O_3

Yttrium (III) Oxide (FW = 225.82)

Sample Description: Y2O3 (99.9%) RMC #71208-13 (exposed to air), screen, 90 TOA

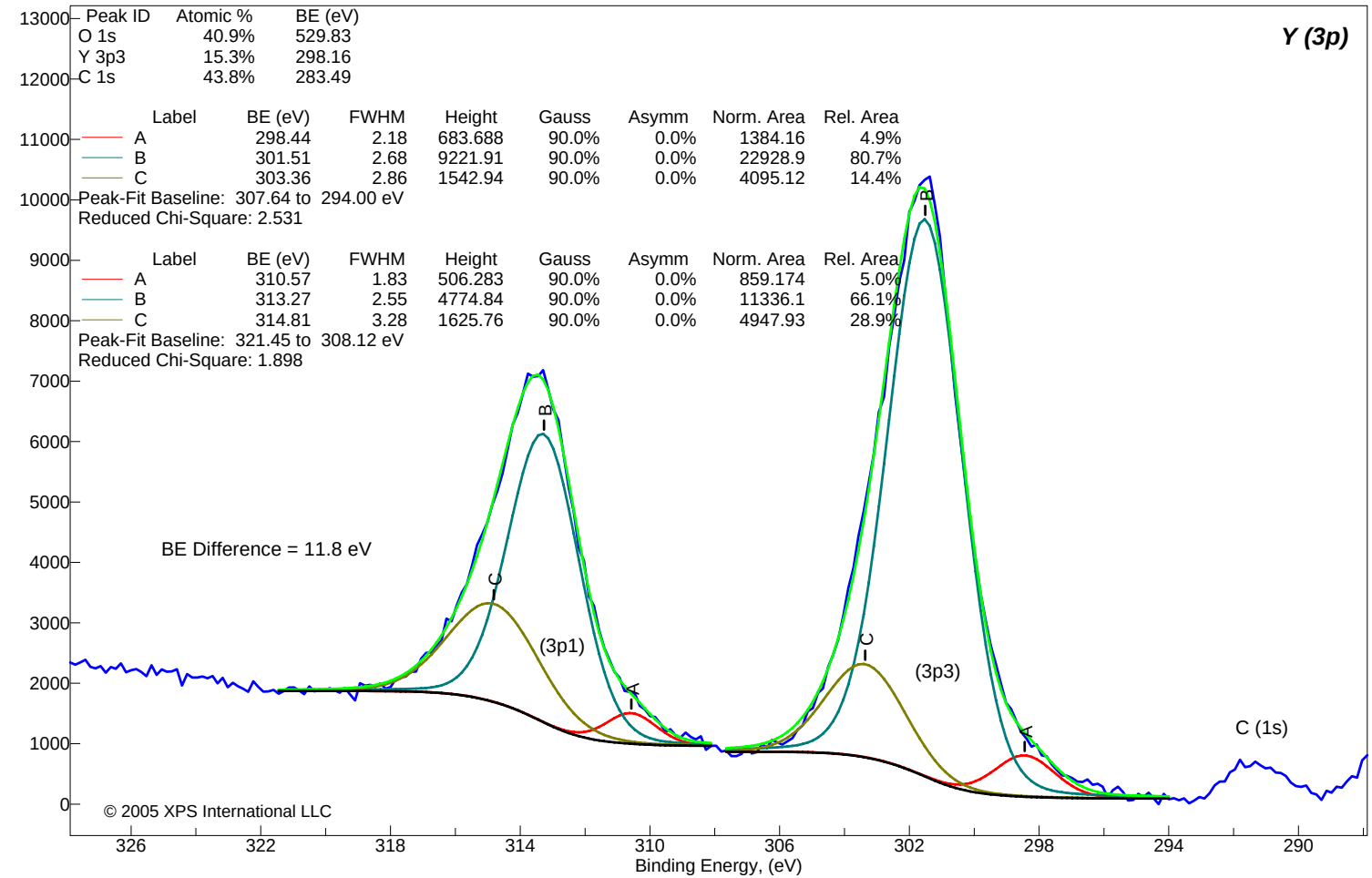


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV
M-2
X1

$Y_2(CO_3)_3$

Yttrium (III) Carbonate (FW = 357.85)
Surface Composition Table

Description: $Y_2(CO_3)_3$-nH_2O (99%) from Aldrich Co., analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white powder pressed into 3 mm pellet

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
Y 4d	8.3	13.3	0.03	1.4	1,338	
Y 4p	21.9	26.9	0.09	1.4	15,086	
Y 4s	42.5	47.5	0.33	1.4	2,758	
Y loss	57.1	62.1	0.00	1.4	688	
Y 3d	154.9	159.9	5.98	1.4	61,799	12.0%
Y loss	179.3	184.3	0.00	1.4	1,676	
Y loss	191.0	196.0	0.00	1.4	3,475	
C 1s	285.9	290.9	1.00	1.4	19,264	25.8%
Y 3p3	297.6	302.6	4.75	1.4	37,208	
Y 3p1	309.3	314.3	2.44	1.4	21,774	
Y loss	320.1	325.1	0.00	1.4	2,131	
Y loss	333.8	338.8	0.00	1.4	1,183	
Y 3s	392.4	397.4	1.98	1.4	9,521	
O 1s	528.3	533.3	2.93	1.4	99,178	62.2%
O loss	544.9	549.9	0.00	1.4	27,909	
O loss	564.5	569.5	0.00	1.4	4,134	
O KLL-1	974.0	979.0	0.70	1.4	15,649	

Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV

$Y_2(CO_3)_3$

Yttrium (III) Carbonate (FW = 357.85)

Sample Description: Y2(CO3)3+nH2O (99%) from Aldrich Chemical
pressed into 3 mm pellet, analyzed at 90 deg TOA, mesh-screen at 1 mm height

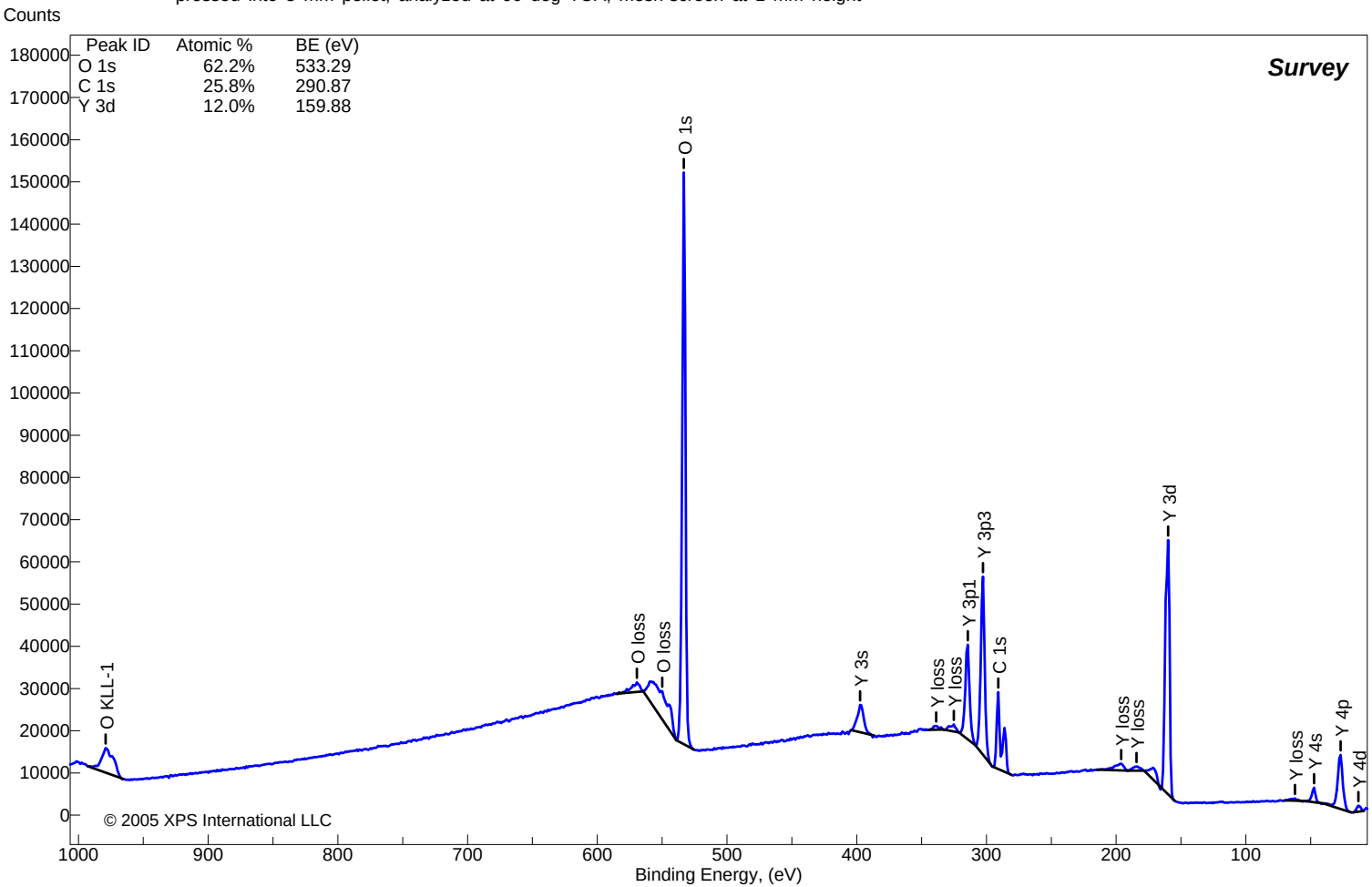


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV

$Y_2(CO_3)_3$

Yttrium (III) Carbonate (FW = 357.85)

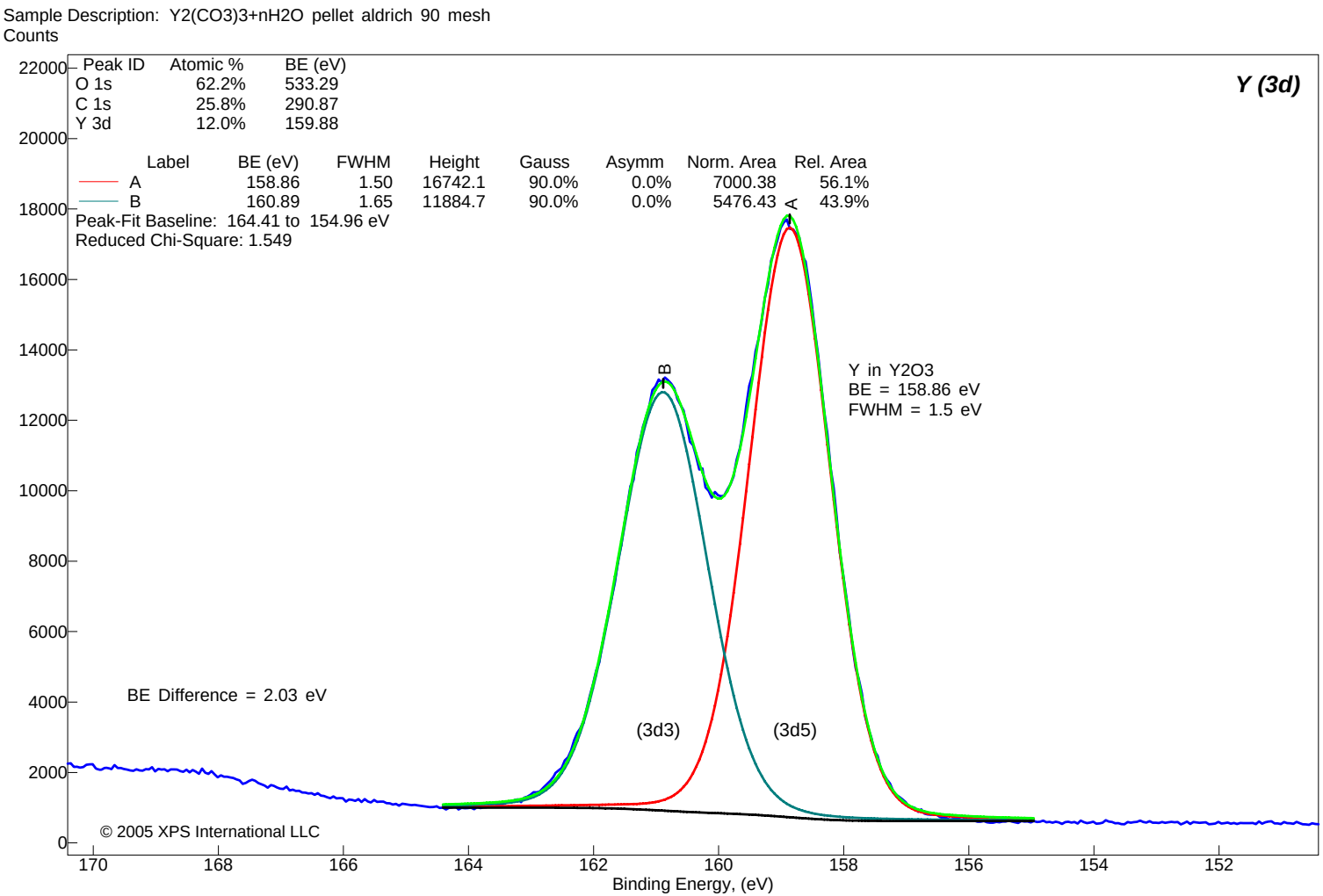


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV

$Y_2(CO_3)_3$

Yttrium (III) Carbonate (FW = 357.85)

Sample Description: Y2(CO3)3+nH2O pellet aldrich 90 mesh

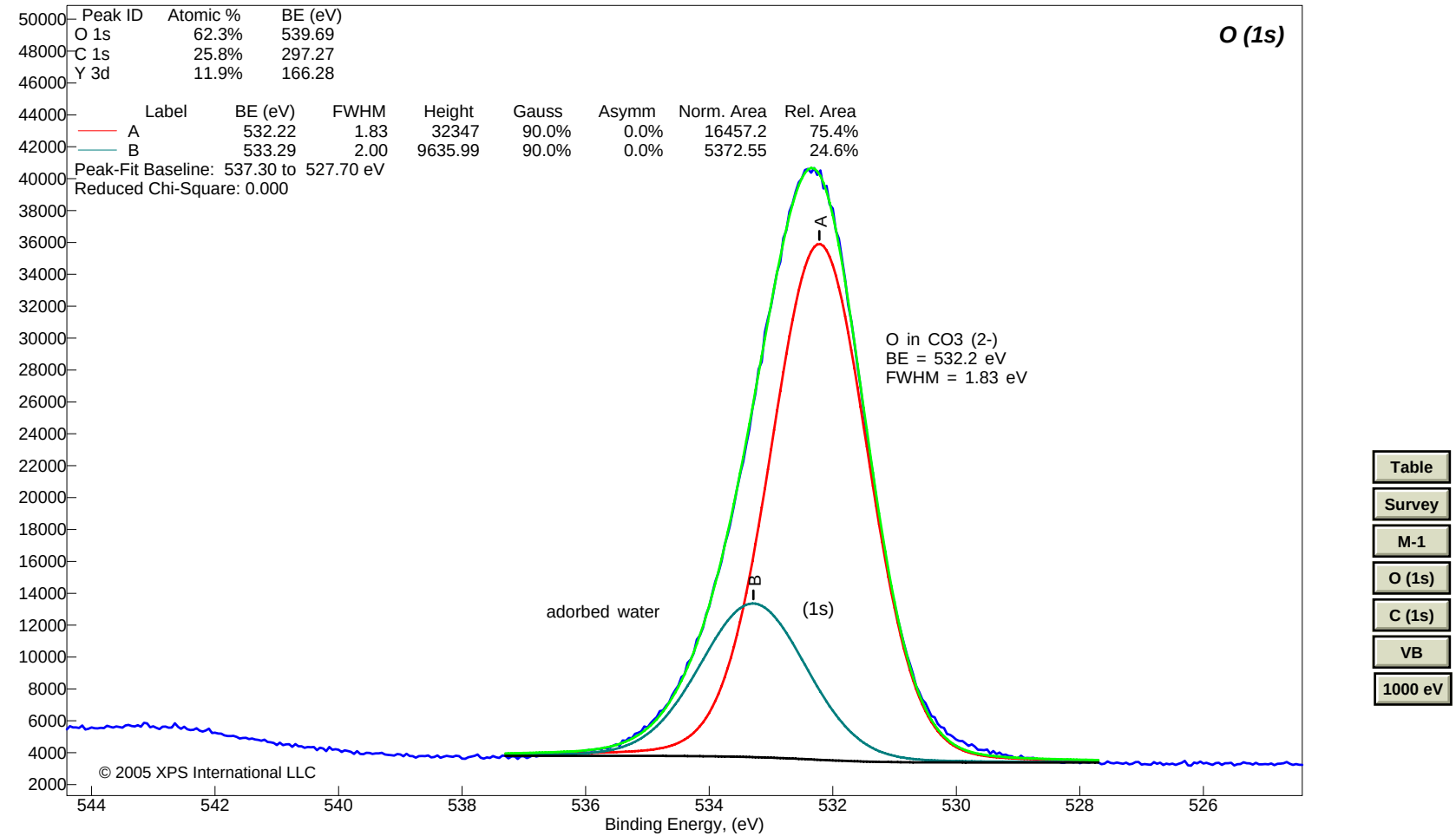
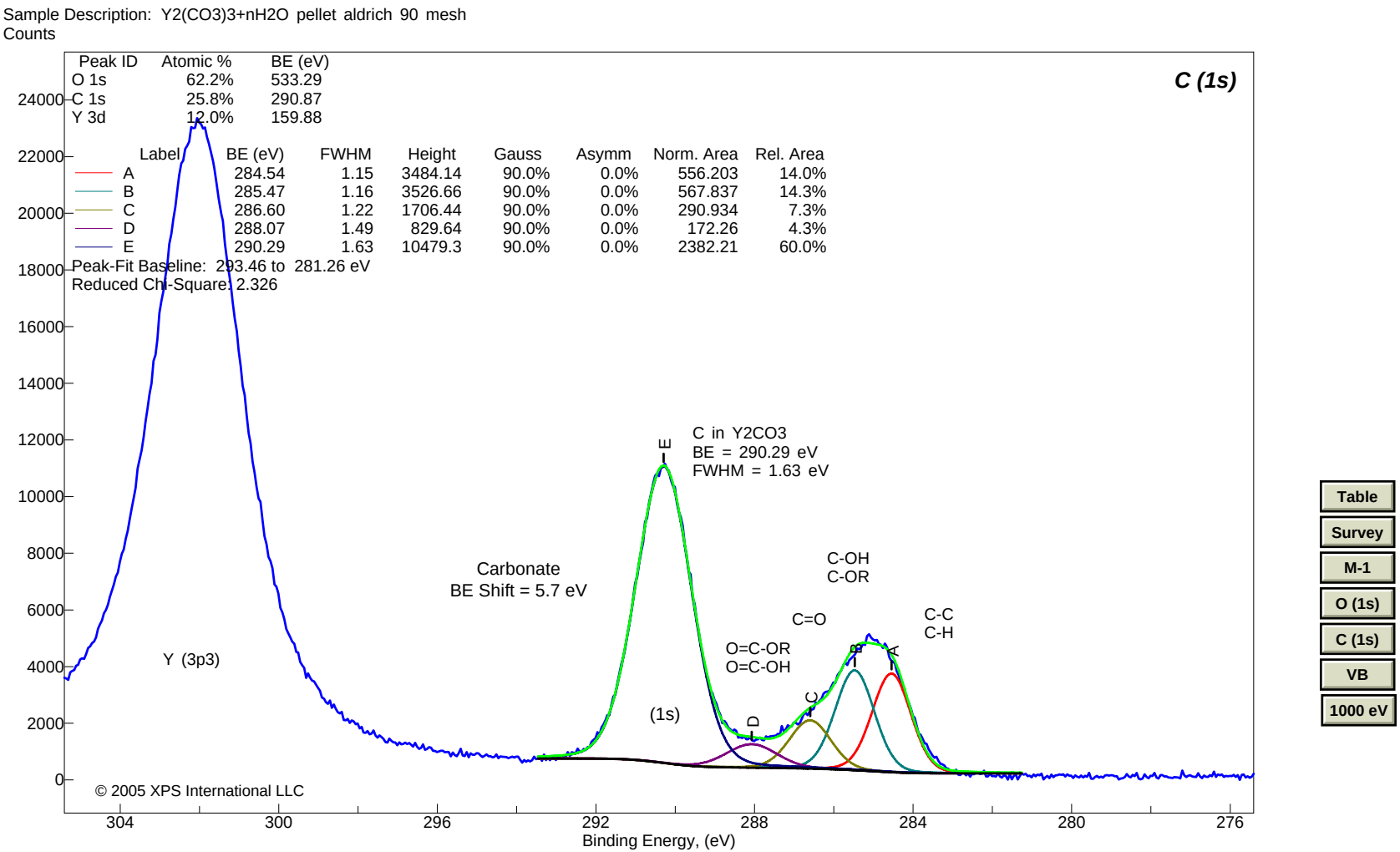


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV

$Y_2(CO_3)_3$

Yttrium (III) Carbonate (FW = 357.85)



$Y_2(CO_3)_3$

Yttrium (III) Carbonate (FW = 357.85)

Sample Description: Y2(CO3)3+nH2O pellet aldrich 90 mesh

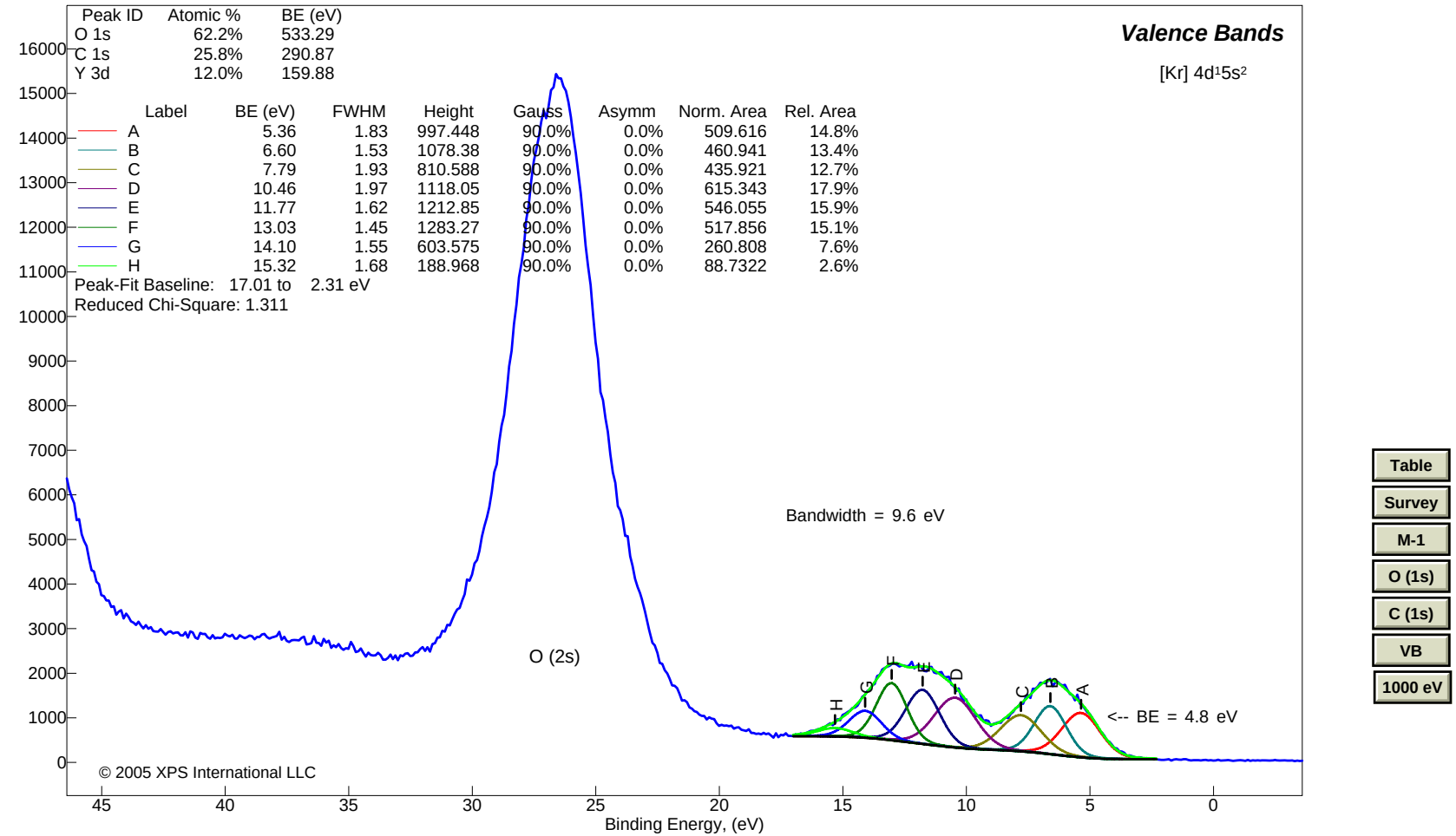


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV

$Y_2(CO_3)_3$

Yttrium (III) Carbonate (FW = 357.85)

Sample Description: Y2(CO3)3+nH2O pellet aldrich 90 mesh

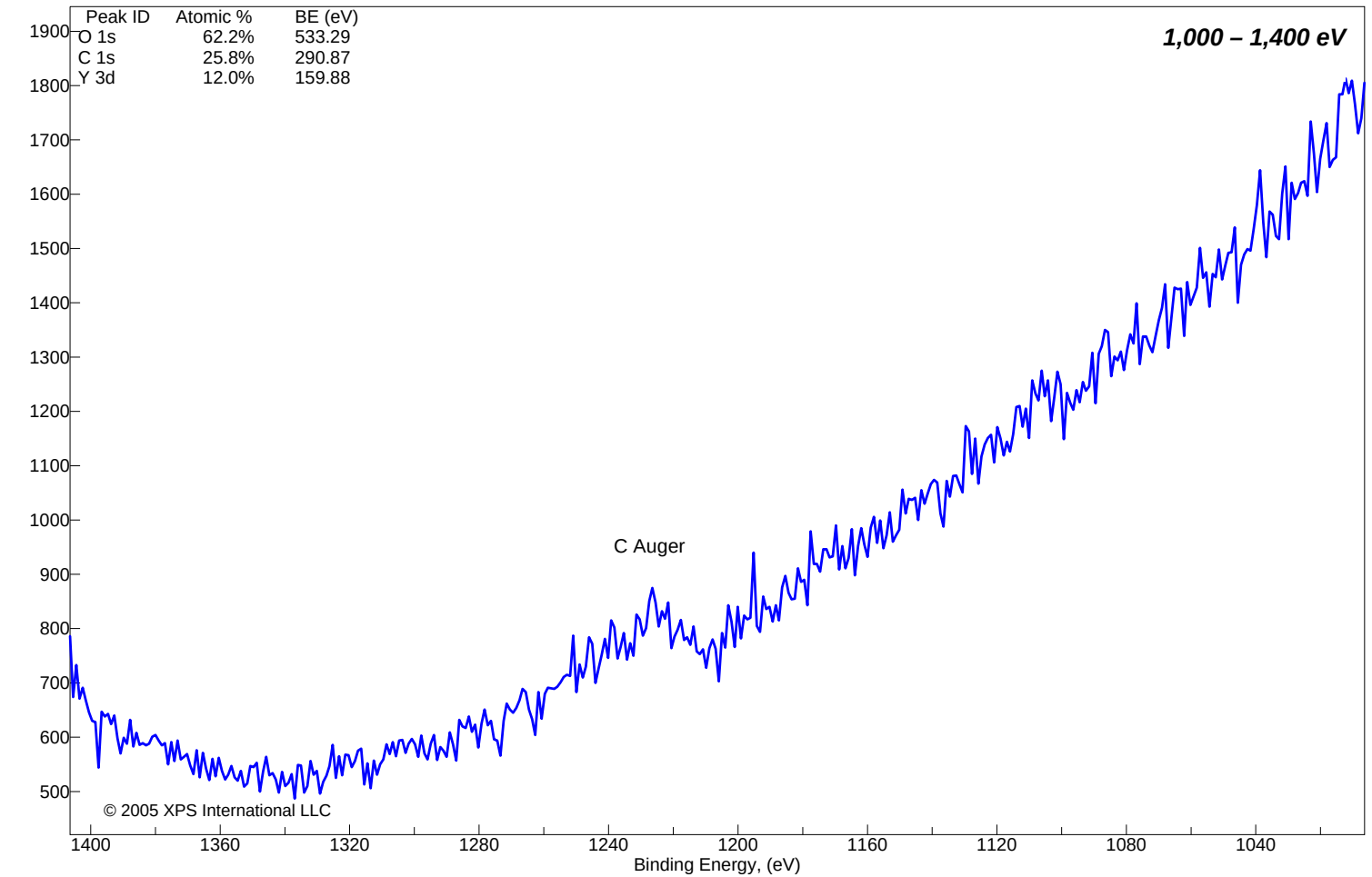


Table
Survey
M-1
O (1s)
C (1s)
VB
1000 eV

Ytterbium (III) Oxide (FW = 394.08)
Surface Composition Table

Description: Yb_2O_3 (99.99%) from Aldrich Co. Lot# 05719PM, analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white powder pressed into 3 mm pellet, mp 2227 C, sol in hot dil acid, very hygroscopic

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
O 2p	7.4	2.7	0.02	1.4	81,626	
Yb (5p) & O (2s)	27.2	22.5	0.88	1.4	45,027	
Yb 5s	56.5	51.8	0.31	1.4	10,173	
Yb loss	70.2	65.5	0.00	1.4	1,720	
Yb 4d5	185.5	180.8	8.07	1.4	49,361	
Yb 4d3	200.2	195.5	5.61	1.4	34,989	
C 1s	285.2	280.5	1.00	1.4	27,955	32.8%
C loss	301.9	297.2	0.00	1.4	1,435	
Yb 4p3	345.8	341.1	4.60	1.4	61,167	16.8%
Yb loss	363.4	358.7	0.00	1.4	4,975	
Yb loss	383.0	378.3	0.00	1.4	1,788	
Yb 4p1	400.6	395.9	2.00	1.4	18,997	
Yb 4s	488.6	483.9	1.70	1.4	18,555	
O 1s	530.6	525.9	2.93	1.4	91,660	50.5%
O loss	547.2	542.5	0.00	1.4	31,163	
O loss	573.6	568.9	0.00	1.4	2,019	
O KLL-1	975.4	970.7	0.70	1.4	15,673	
O Auger	996.9	992.2	0.00	1.4	5,290	

Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV

Yb_2O_3

Ytterbium (III) Oxide (FW = 394.08)

Sample Description: Yb2O3 (99.99%) from Aldrich lot# 05719PM
pressed into 3 mm pellet, analyzed at 90 deg TOA, mesh-screen at 1 mm height

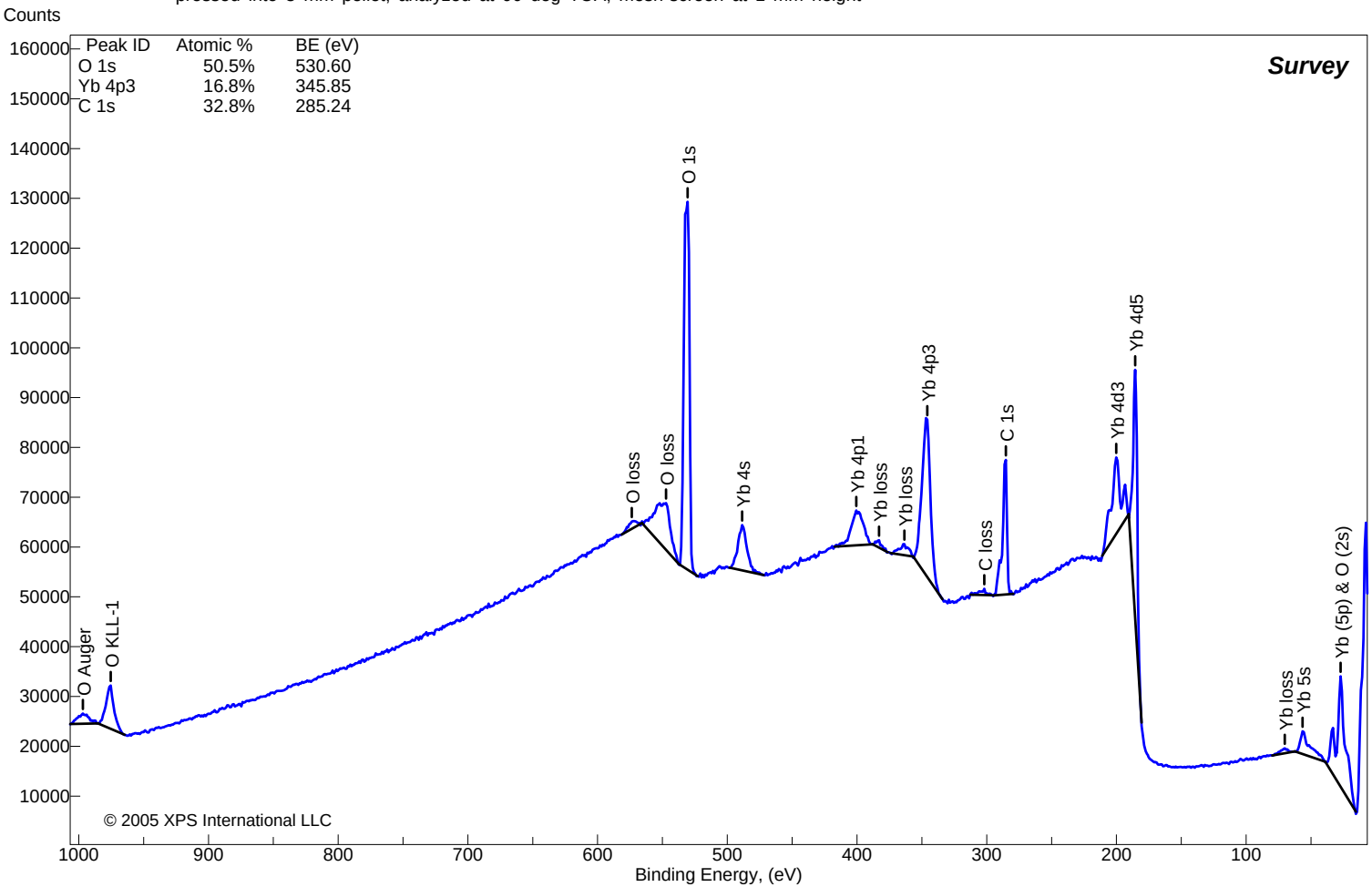


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV

Ytterbium (III) Oxide (FW = 394.08)

Sample Description: Yb2O3 99.99% Aldr lot#05719PM 3mm plt 90TOA mesh
mesh at <1mm

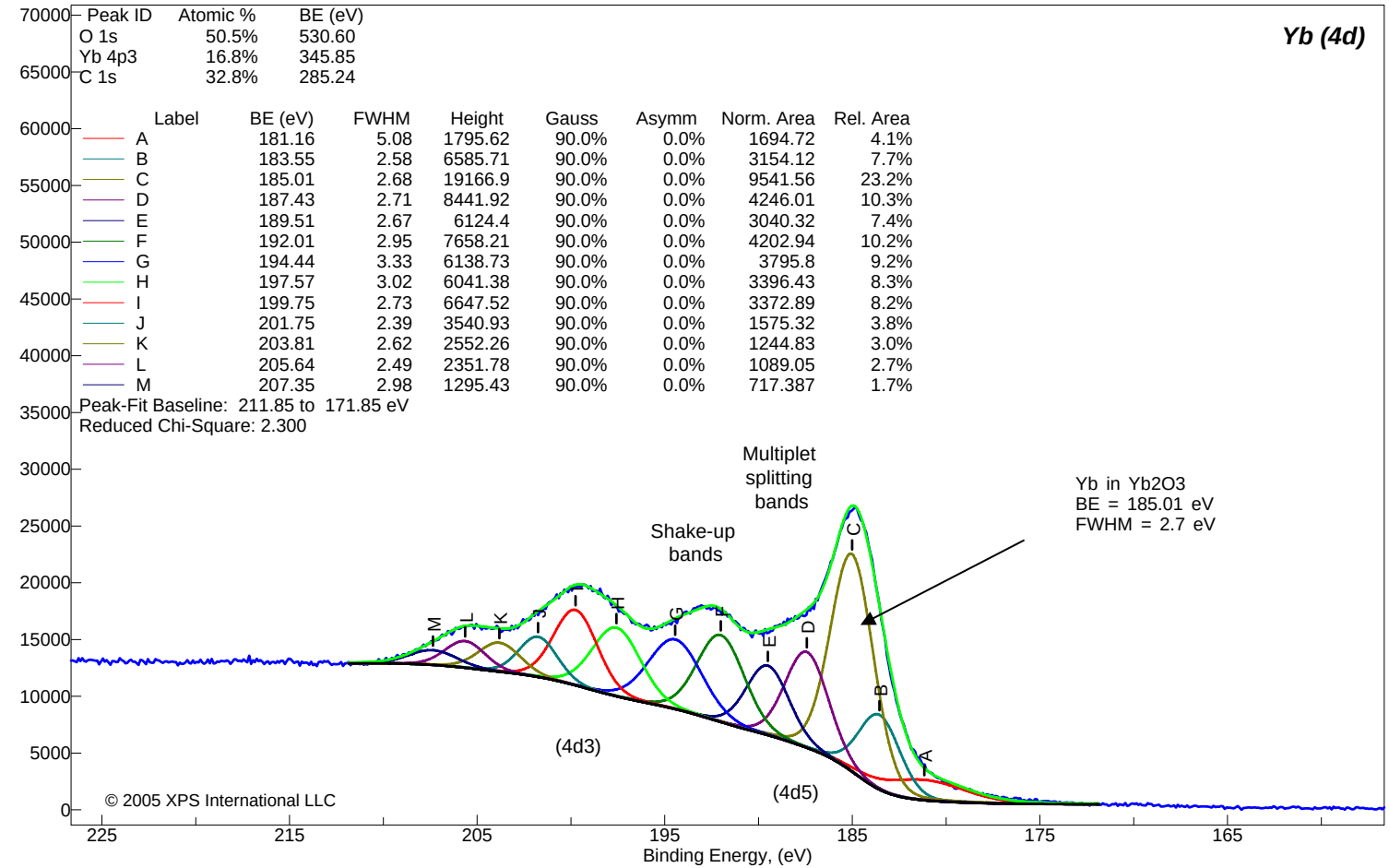


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV

Ytterbium (III) Oxide (FW = 394.08)

Sample Description: Yb2O3 99.99% Aldr lot#05719PM 3mm plt 90TOA mesh
mesh at <1mm

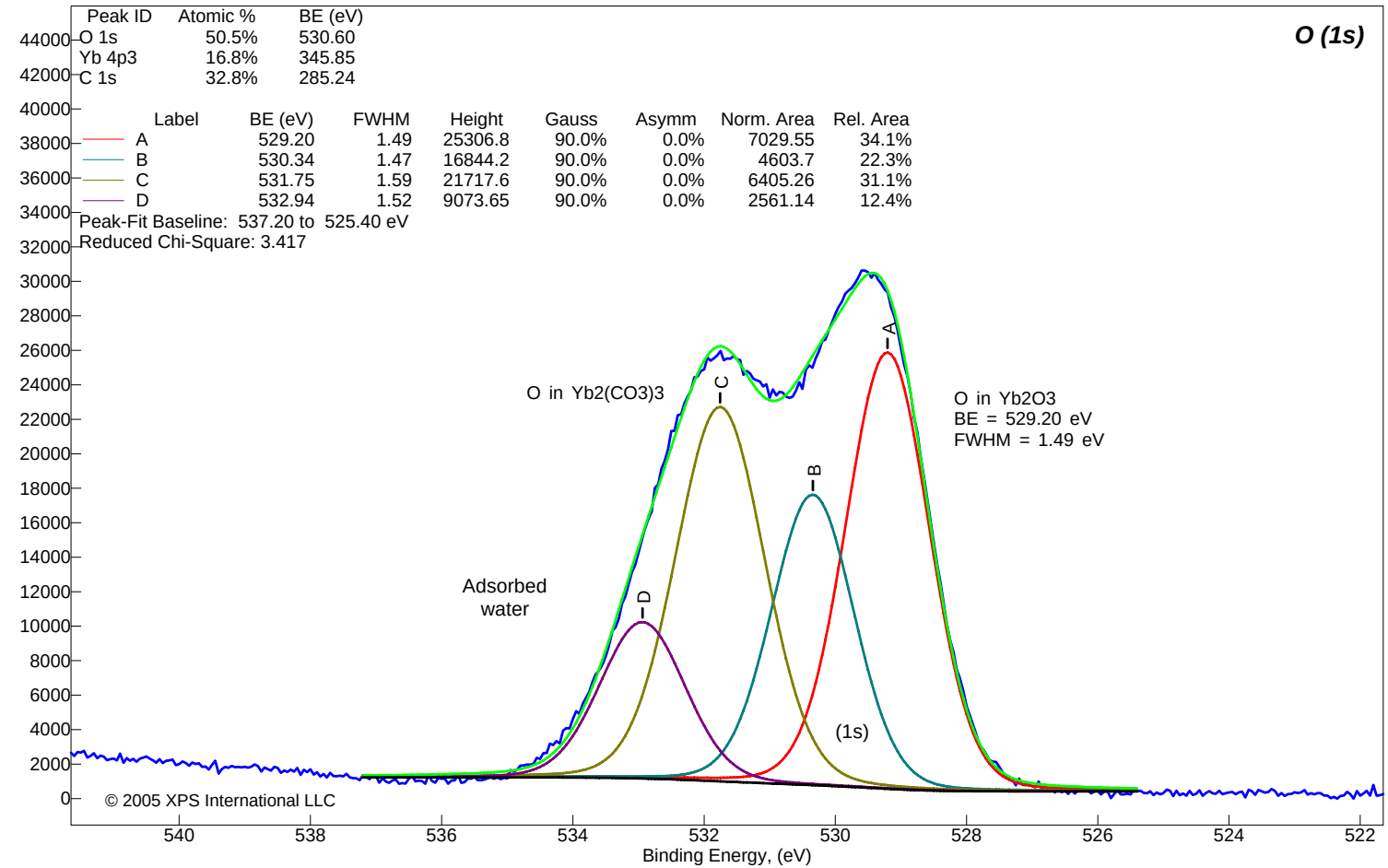


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV

Ytterbium (III) Oxide (FW = 394.08)

Sample Description: Yb2O3 99.99% Aldr lot#05719PM 3mm plt 90TOA mesh
mesh at <1mm

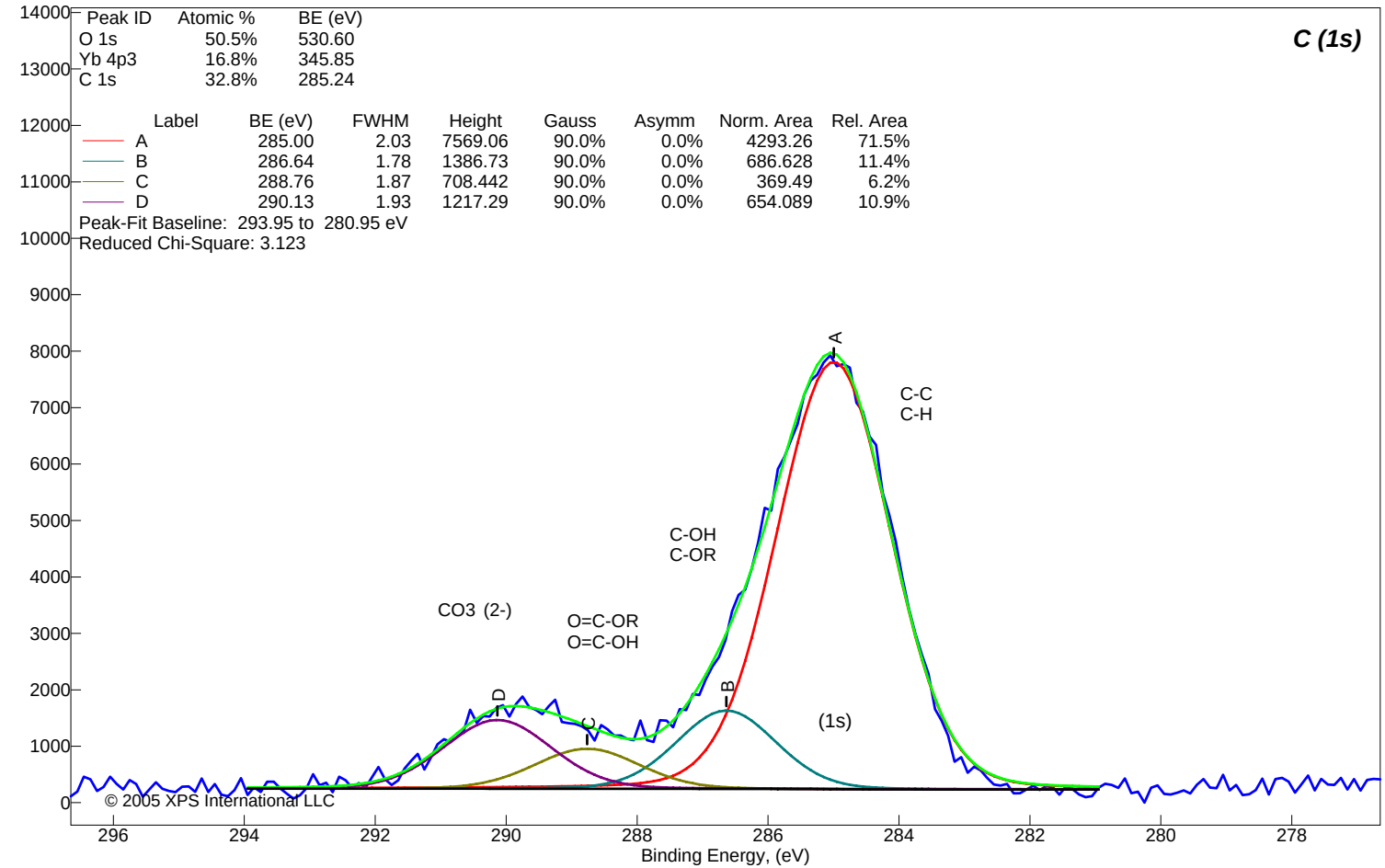


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV

Ytterbium (III) Oxide (FW = 394.08)

Sample Description: Yb2O3 99.99% Aldr lot#05719PM 3mm plt 90TOA mesh
mesh at <1mm

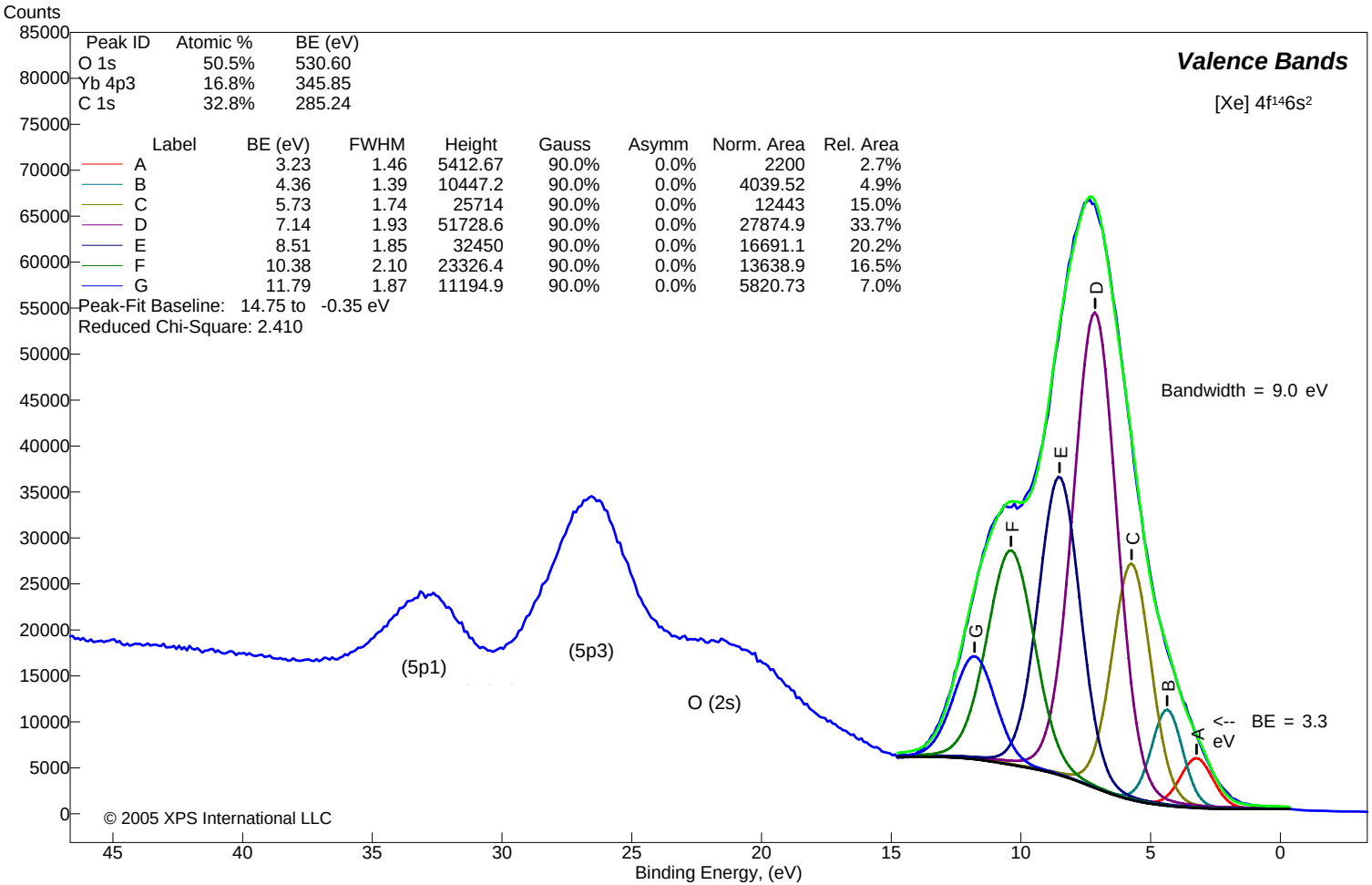


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV

Yb_2O_3

Ytterbium (III) Oxide (FW = 394.08)

Sample Description: Yb2O3 99.99% Aldr lot#05719PM 3mm plt 90TOA mesh
mesh at <1mm

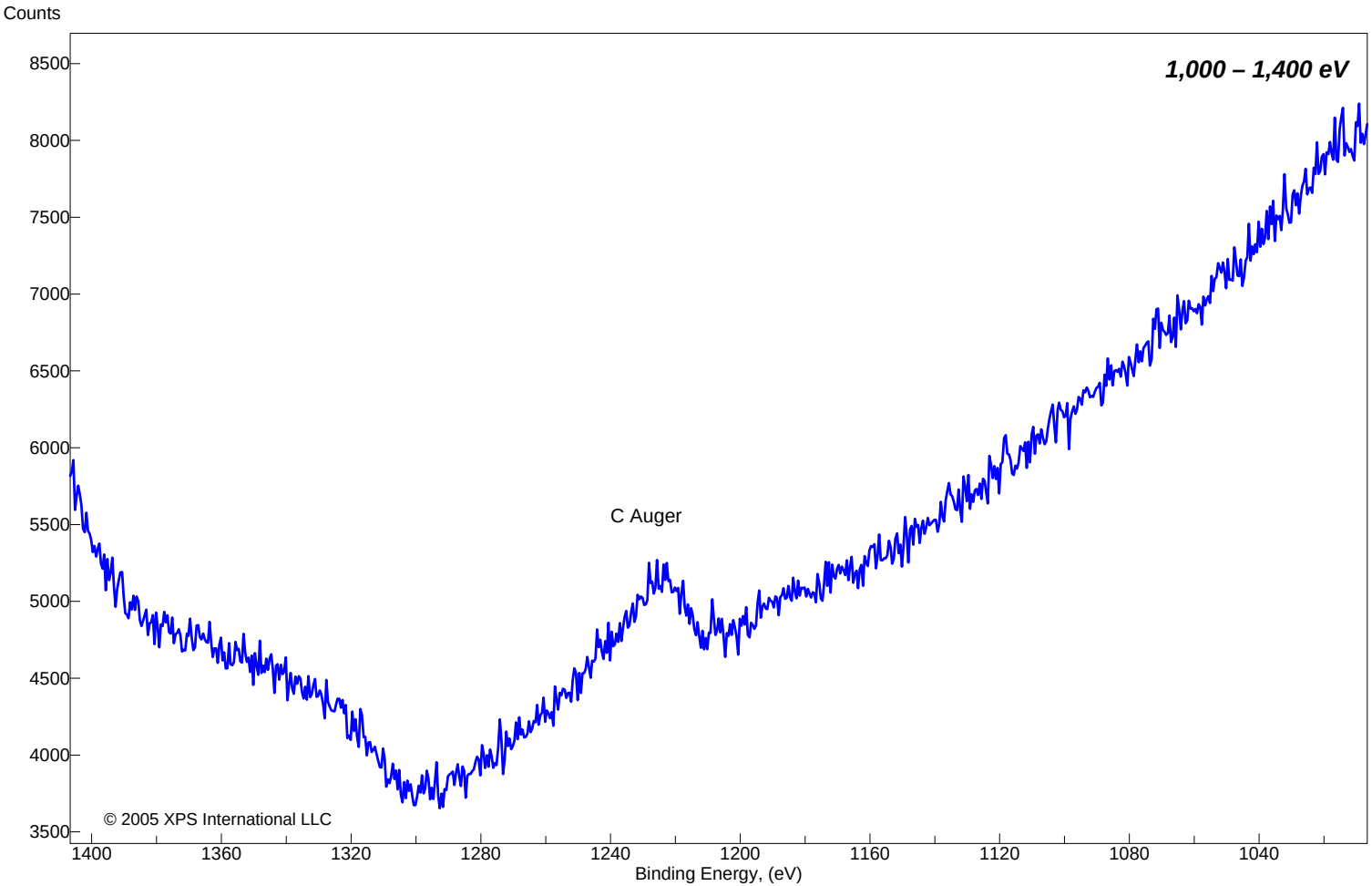


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV

ZnO

Zinc (II) Oxide (FW = 81.38)
Surface Composition Table

Description: ZnO (99.999%) from Aldrich Co. Lot# 04629KV, analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white powder pressed into 3 mm pellet, mp 1975 C, d 5.60, sol in dil acetic acid

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
Zn 3d	9.2	14.4	0.81	1.5	26,974	
O 2s	21.9	27.1	0.14	1.5	8,342	
Zn 3p	88.4	93.6	2.83	1.5	66,896	
Zn loss	108.0	113.2	0.00	1.5	12,224	
Zn 3s	139.3	144.5	1.04	1.5	24,230	
Zn loss	158.8	164.0	0.00	1.5	3,953	
C 1s	285.0	290.2	1.00	1.5	14,933	22.9%
N 1s	399.4	404.6	1.80	1.5	652	0.6%
Zn Auger	459.0	464.2	0.00	1.5	1,662	
Zn Auger	474.7	479.9	0.00	1.5	51,945	
Zn LMM-2	498.1	503.3	0.29	1.5	120,688	
Zn loss	516.7	521.9	0.00	1.5	10,041	
O 1s	530.4	535.6	2.93	1.5	56,357	41.5%
Zn Auger	561.7	566.9	0.00	1.5	31,035	
Zn Auger	585.1	590.3	0.00	1.5	64,302	
Zn loss	605.7	610.9	0.00	1.5	8,587	
Zn Auger	639.9	645.1	0.00	1.5	11,942	
Zn Auger	655.5	660.7	0.00	1.5	35,918	
Zn Auger	702.5	707.7	0.00	1.5	4,178	
Zn Auger	716.2	721.4	0.00	1.5	5,597	
O KLL-1	976.3	981.5	0.70	1.5	12,344	
O Auger	995.8	1001.0	0.00	1.5	3,954	
Zn 2p3	1021.2	1026.4	18.92	1.5	103,677	34.9%
Zn 2p1	1043.7	1048.9	9.80	1.5	67,553	
Zn loss	1063.3	1068.5	0.00	1.5	18,196	

Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

ZnO

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) from Aldrich Lot# HW 04629KV
pressed into 3 mm pellet, analyzed at 90 deg TOA, mesh-screen at 1 mm height

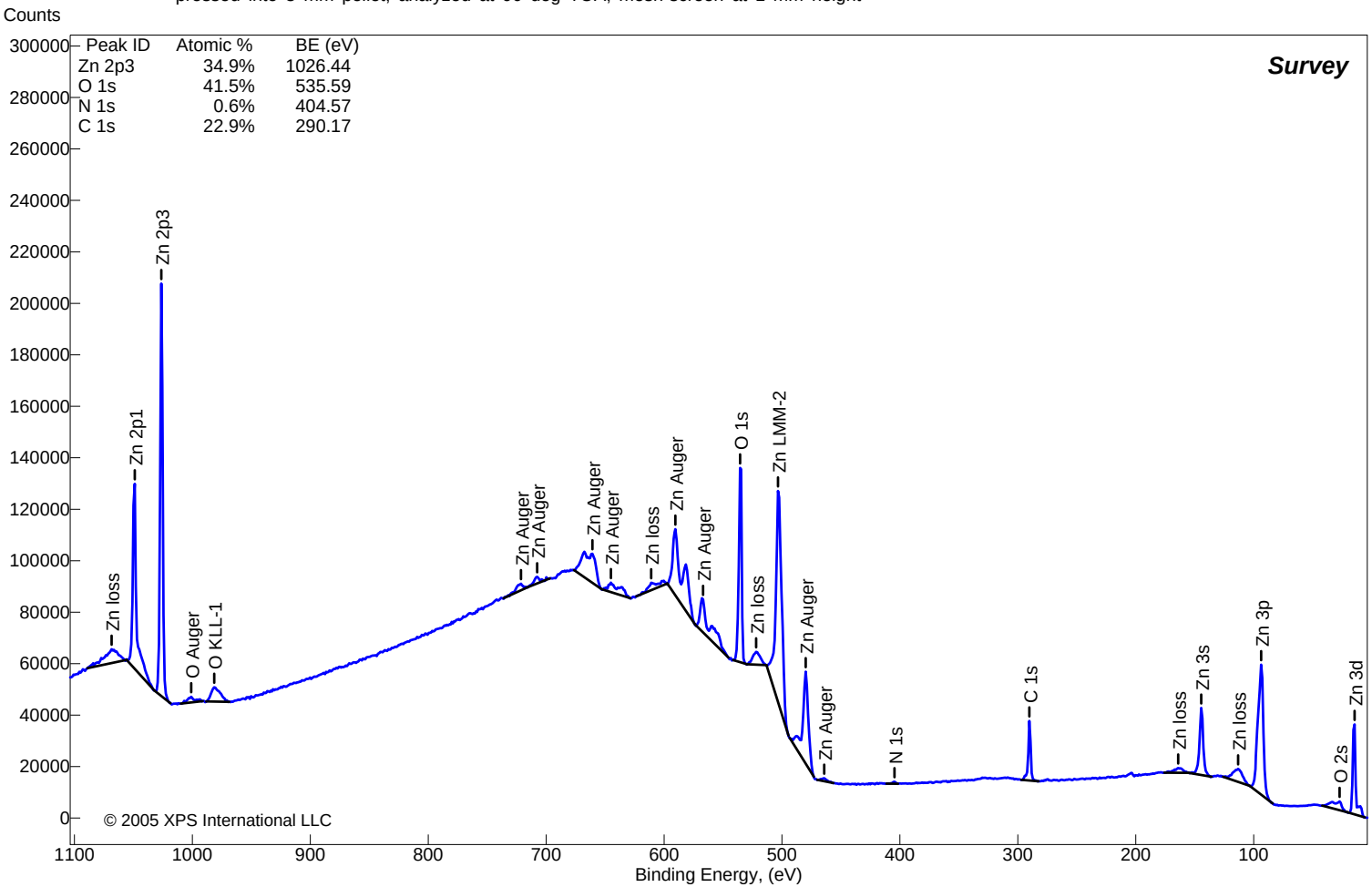


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

ZnO

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) Aldrich Lot# HW 04629KV, 3mm pellet, screen, 90 TOA

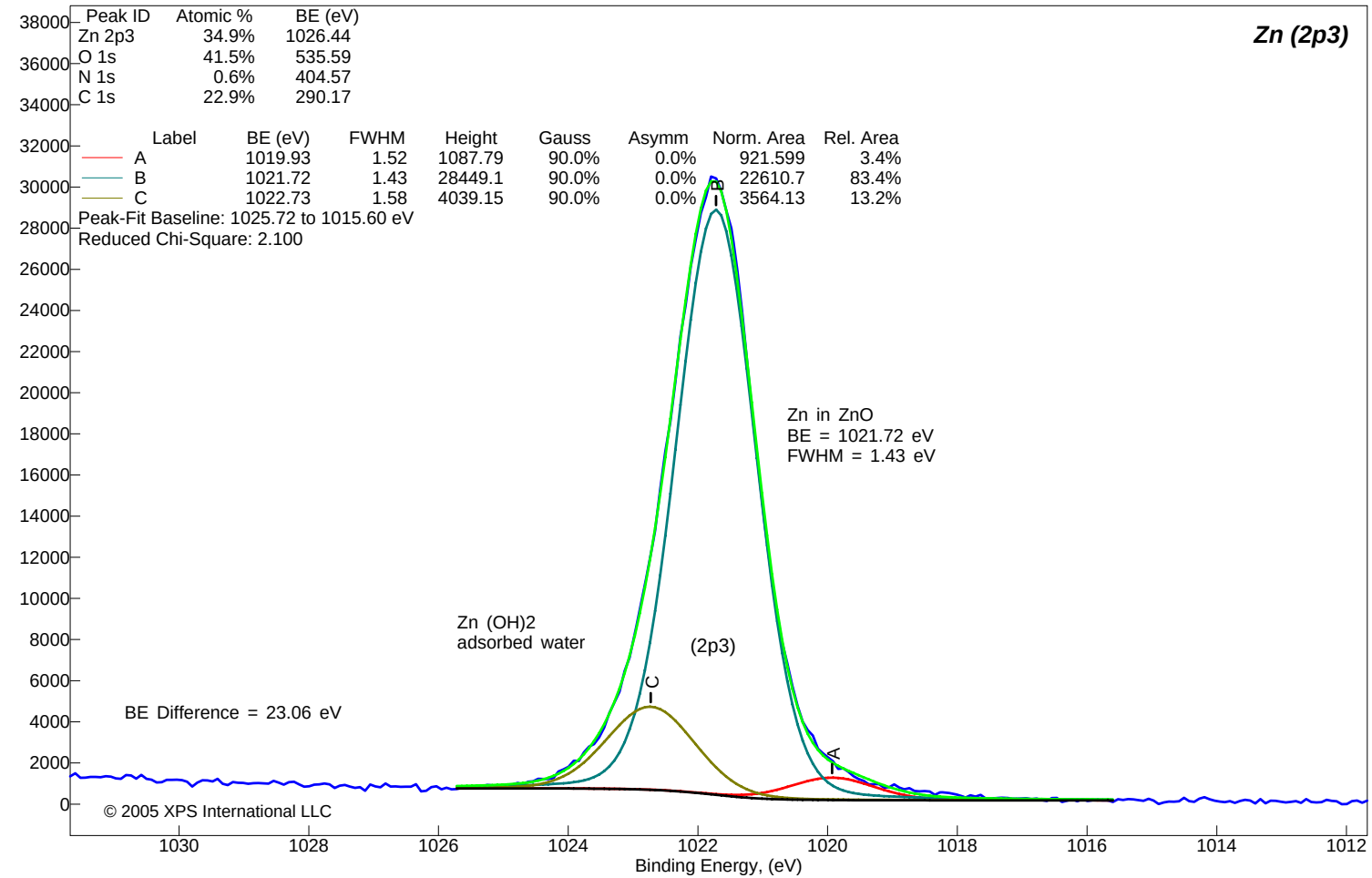


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) Aldrich Lot# HW 04629KV, 3mm pellet, screen, 90 TOA

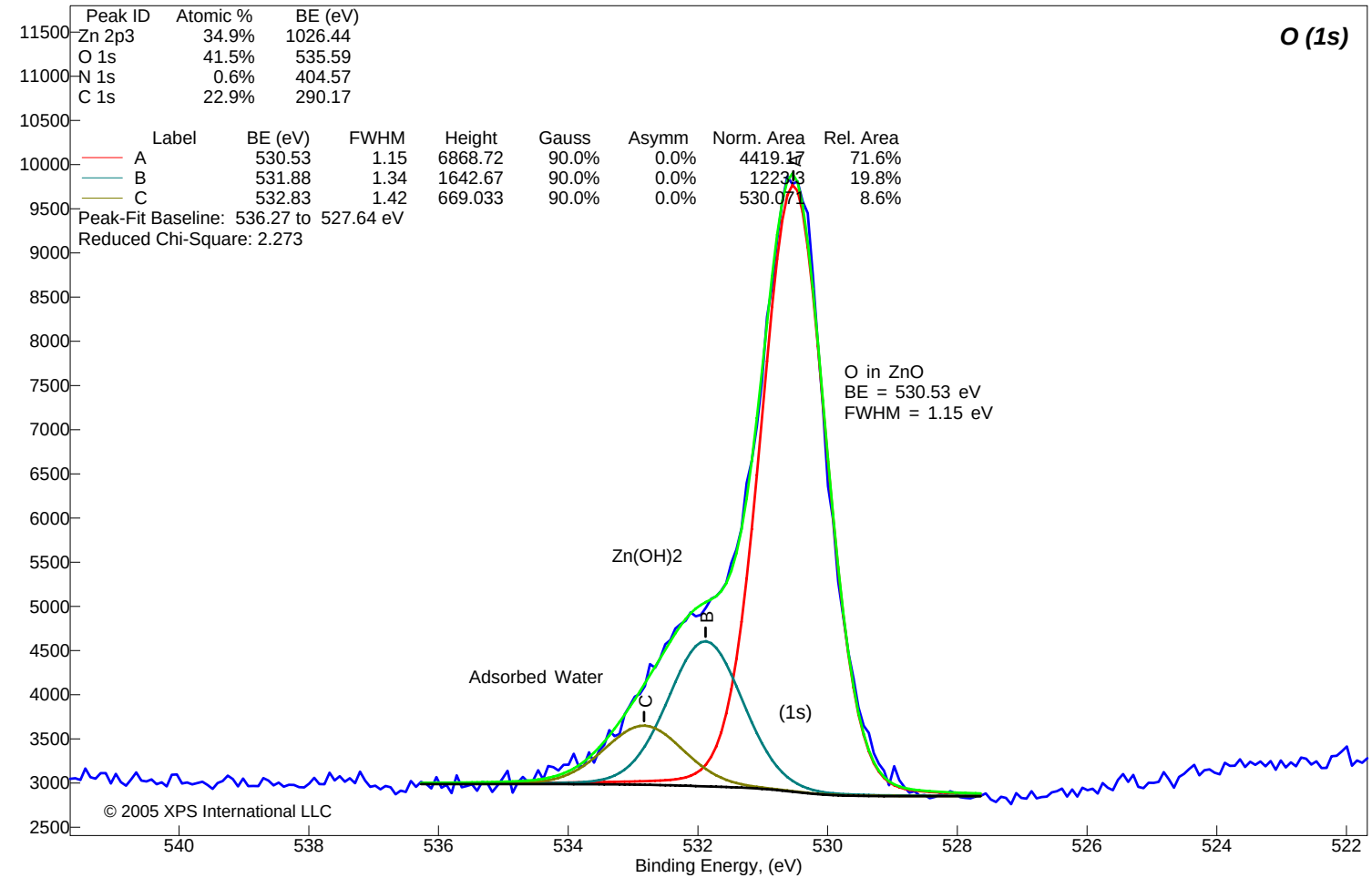


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

ZnO

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) Aldrich Lot# HW 04629KV, 3mm pellet, screen, 90 TOA

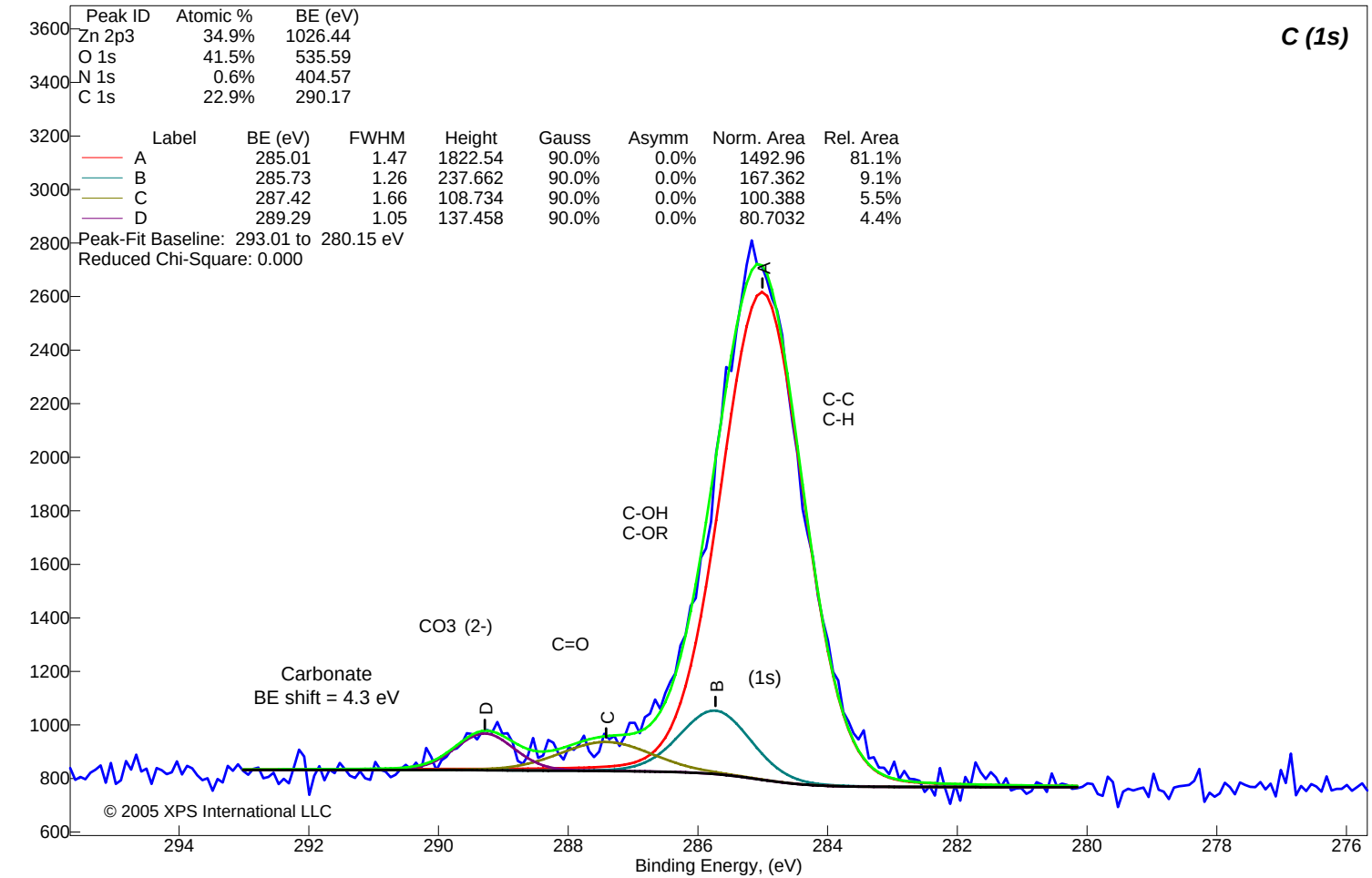


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

ZnO

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) Aldrich Lot# HW 04629KV, 3mm pellet, screen, 90 TOA

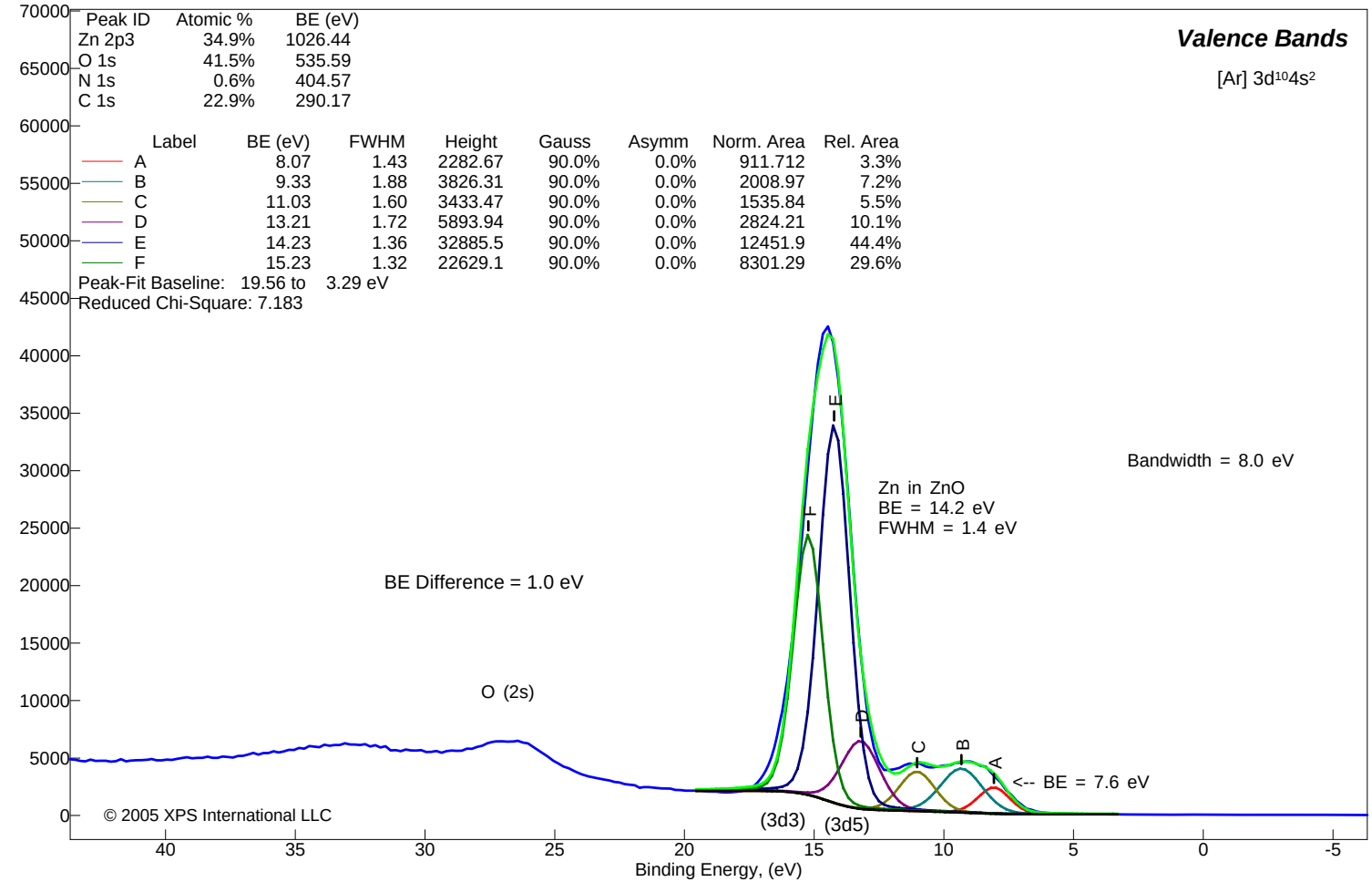


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

ZnO

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) Aldrich Lot# HW 04629KV, 3mm pellet, screen, 90 TOA

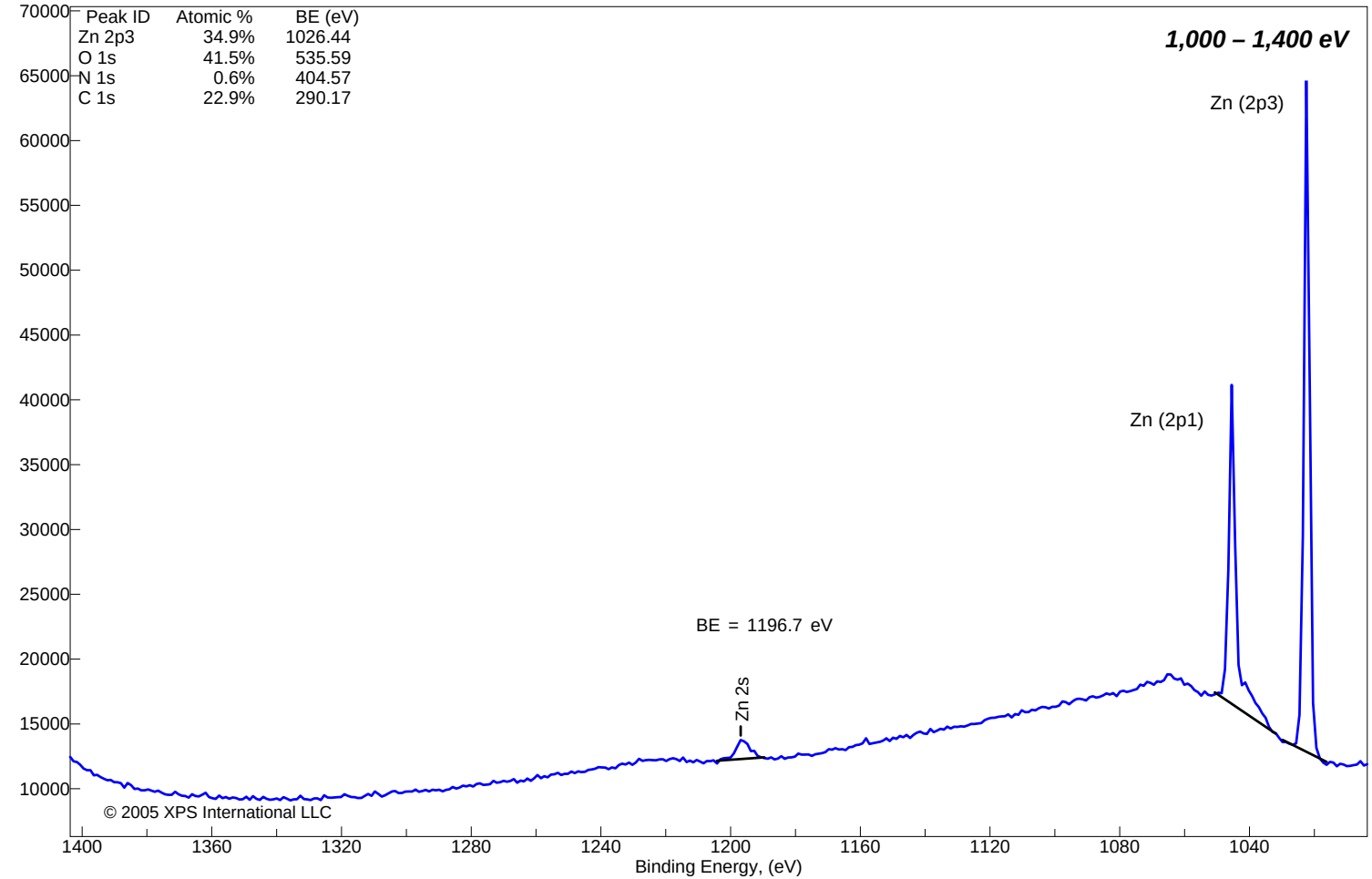


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

ZnO

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) Aldrich Lot# HW 04629KV, 3mm pellet, screen, 90 TOA

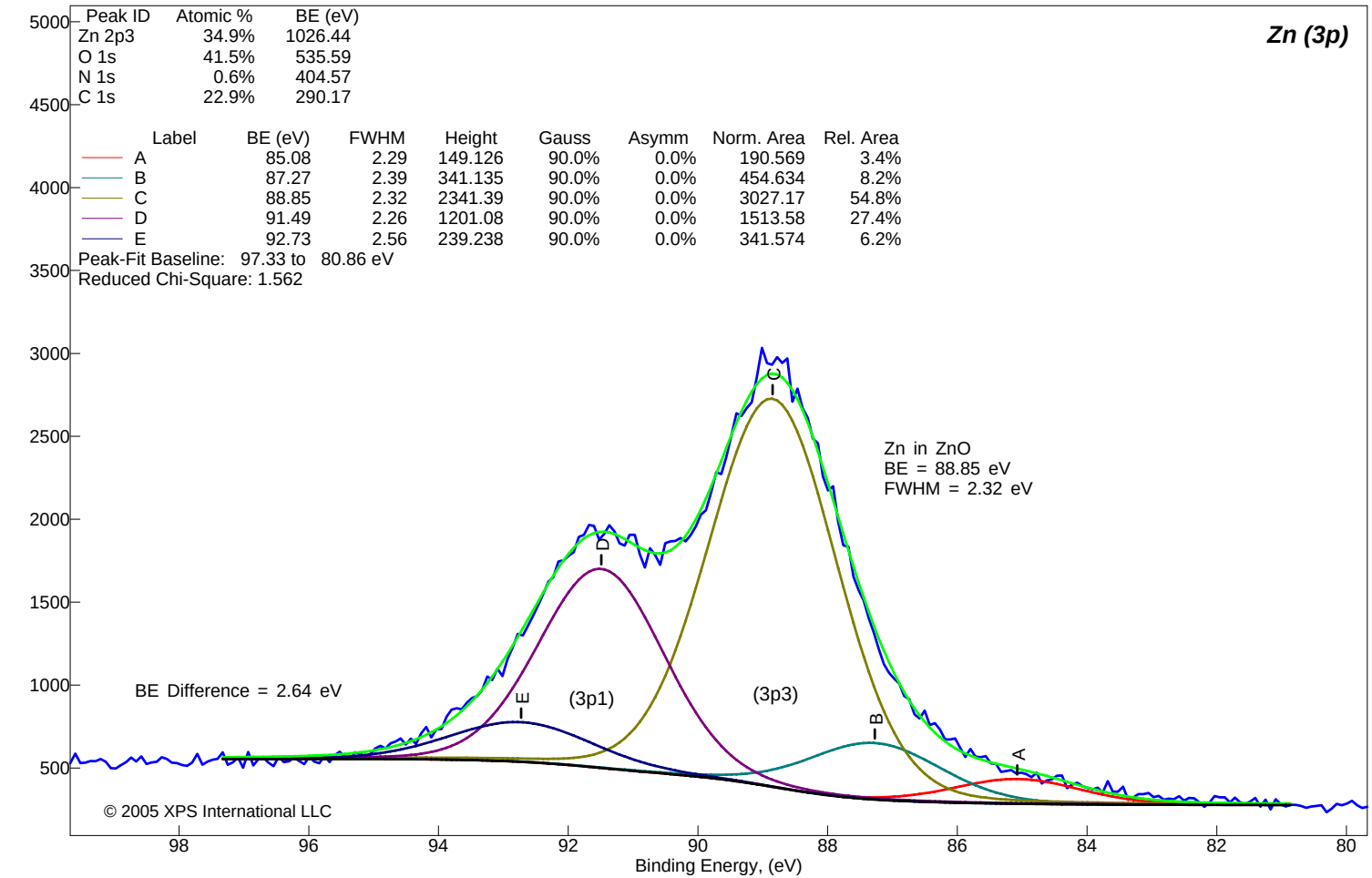


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

ZnO

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) Aldrich Lot# HW 04629KV, 3mm pellet, screen, 90 TOA

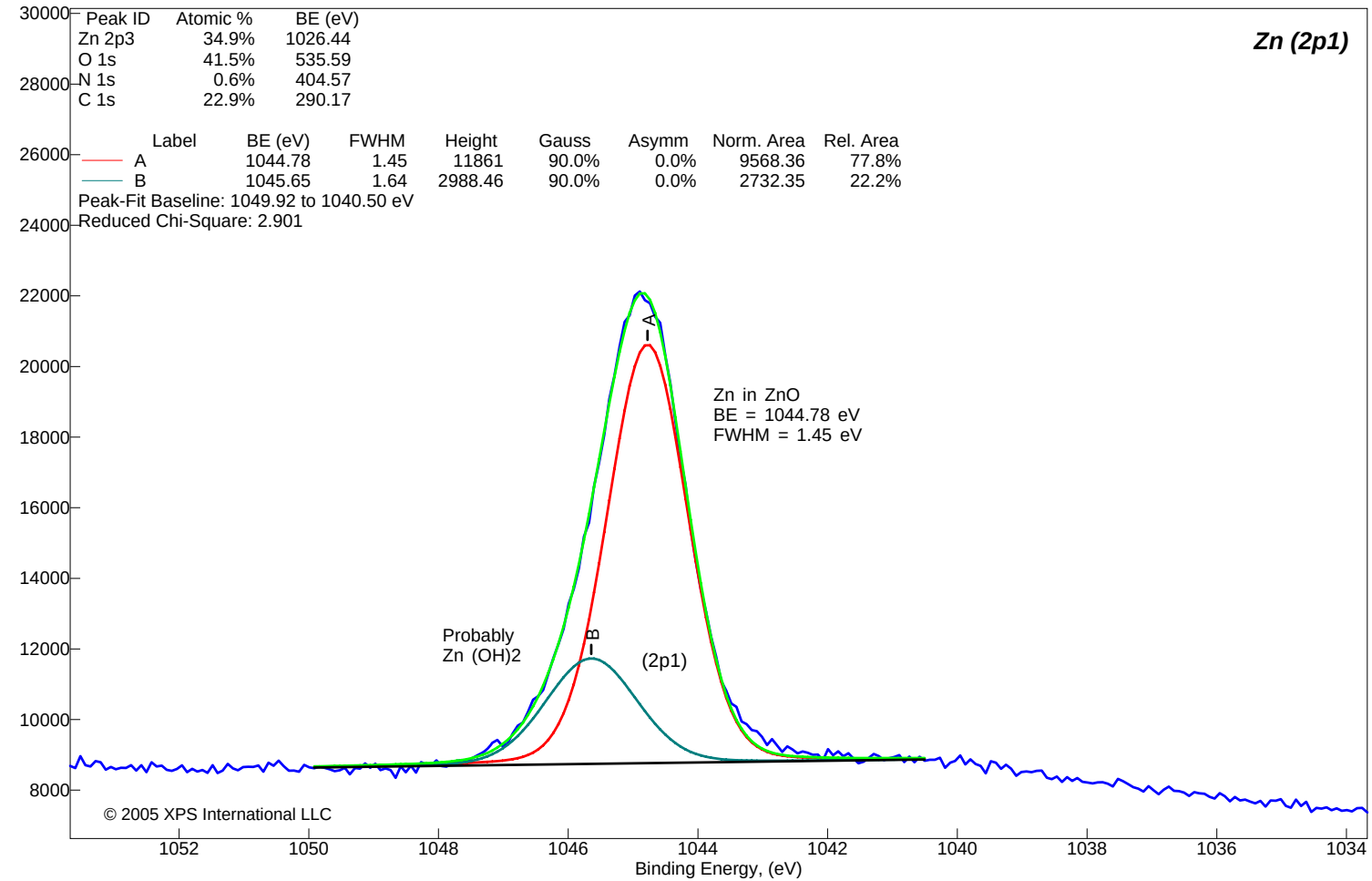


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

ZnO

Zinc (II) Oxide (FW = 81.38)

Sample Description: ZnO (99.999%) Aldrich Lot# HW 04629KV, 3mm pellet, screen, 90 TOA

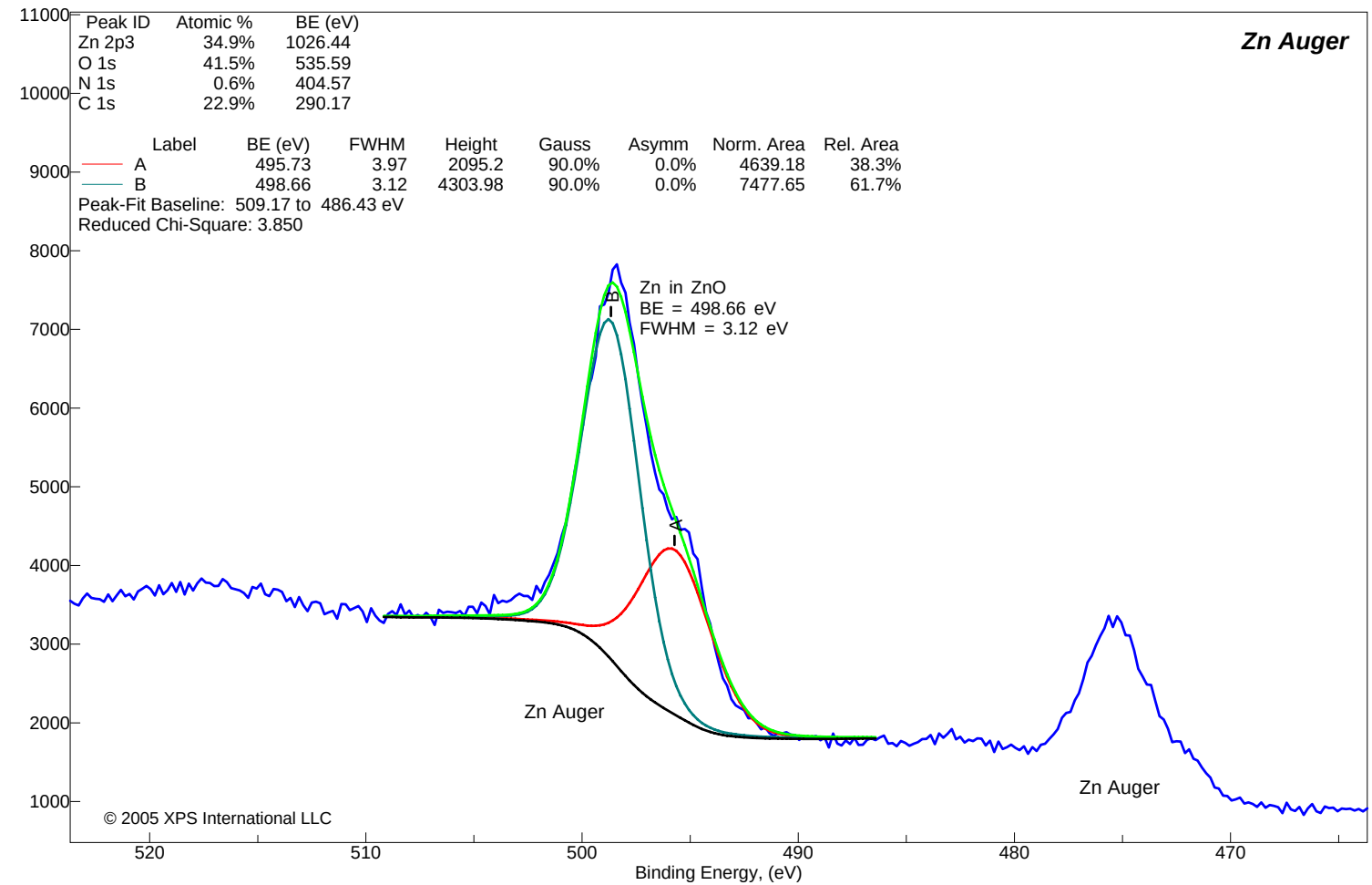


Table
Survey
M #1
O (1s)
C (1s)
VB
1000 eV
M #2
X1
X2

Zirconium (IV) Oxide (FW = 123.22)
Surface Composition Table

Description: ZrO_2 (99.9%, < 100 ppm HfO_2) from Aldrich Co. Lot# 02310BV, analyzed at 90 deg TOA, mesh at 1 mm, non-conductive white powder pressed into 3 mm pellet, mp 2700 C, d 5.89, slightly sol in HCl

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
Zr 4p	31.0	32.0	1.05	1.5	24,137	
Zr 4s	53.5	54.5	0.37	1.5	9,952	
Zr loss	71.1	72.1	0.00	1.5	1,739	
Zr 3d	182.6	183.6	7.04	1.5	130,138	20.9%
Zr loss	197.2	198.2	0.00	1.5	23,850	
Zr loss	209.9	210.9	0.00	1.5	4,906	
Zr loss	226.5	227.5	0.00	1.5	12,909	
C 1s	285.2	286.2	1.00	1.5	19,708	25.2%
Zr 3p3	333.1	334.1	5.14	1.5	74,274	
Zr 3p1	346.8	347.8	2.64	1.5	50,940	
Zr loss	360.5	361.5	0.00	1.5	8,457	
Zr loss	374.2	375.2	0.00	1.5	4,738	
Zr 3s	433.8	434.8	2.10	1.5	20,668	
O 1s	530.6	531.6	2.93	1.5	87,815	54.0%
O loss	545.2	546.2	0.00	1.5	17,091	
O loss	571.6	572.6	0.00	1.5	6,764	
O KLL-1	976.3	977.3	0.70	1.5	19,912	
O Auger	995.9	996.9	0.00	1.5	4,969	

Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) from Aldrich Lot# 02310BV (<100 ppm HfO2), pressed into 3 mm pellet, analyzed at 35deg TOA, mesh-screen at 1 mm height

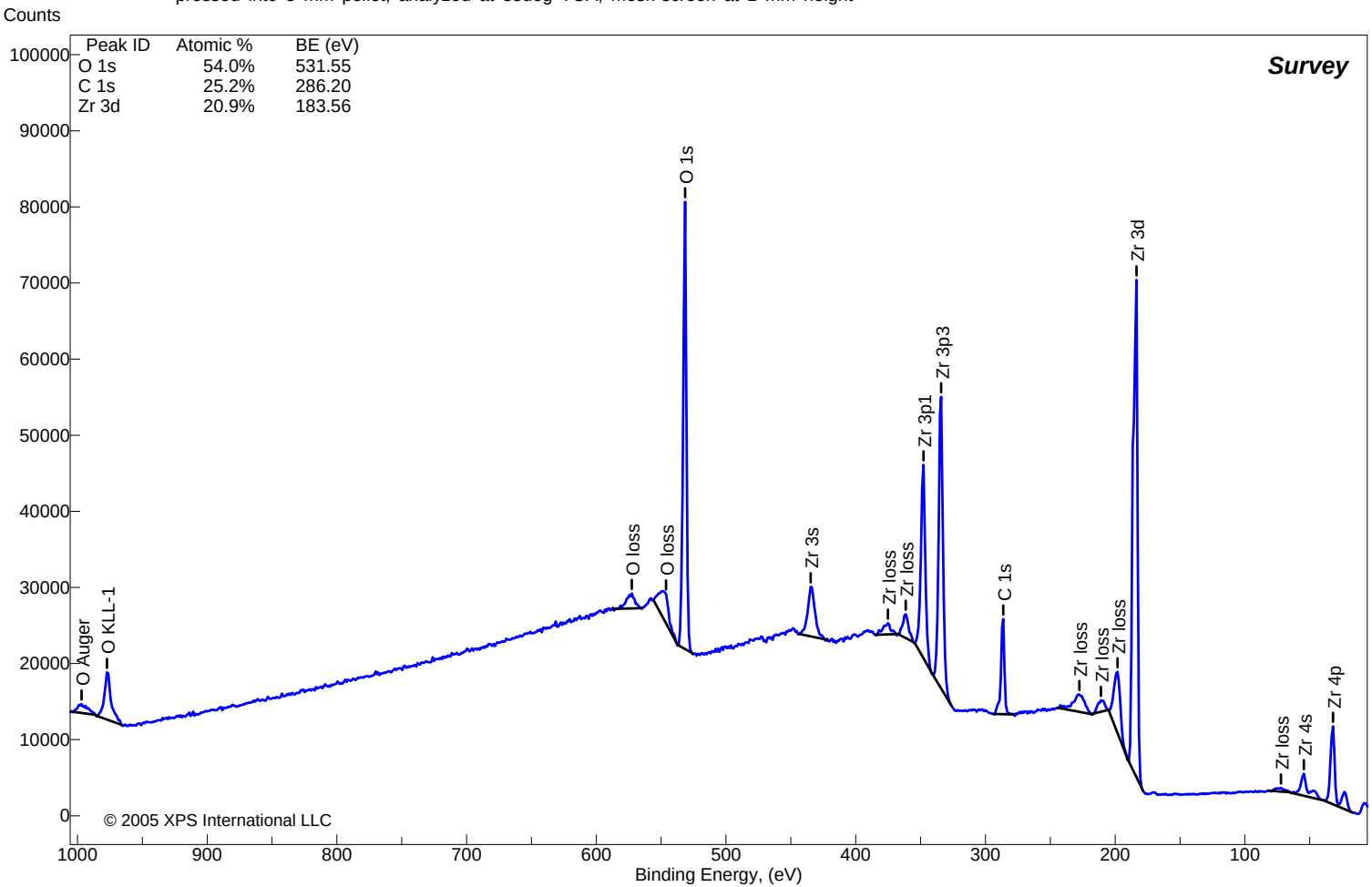


Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) Aldrich Lot# 02310BV, 3mm pellet (<100 ppm HfO2), 35 deg TOA

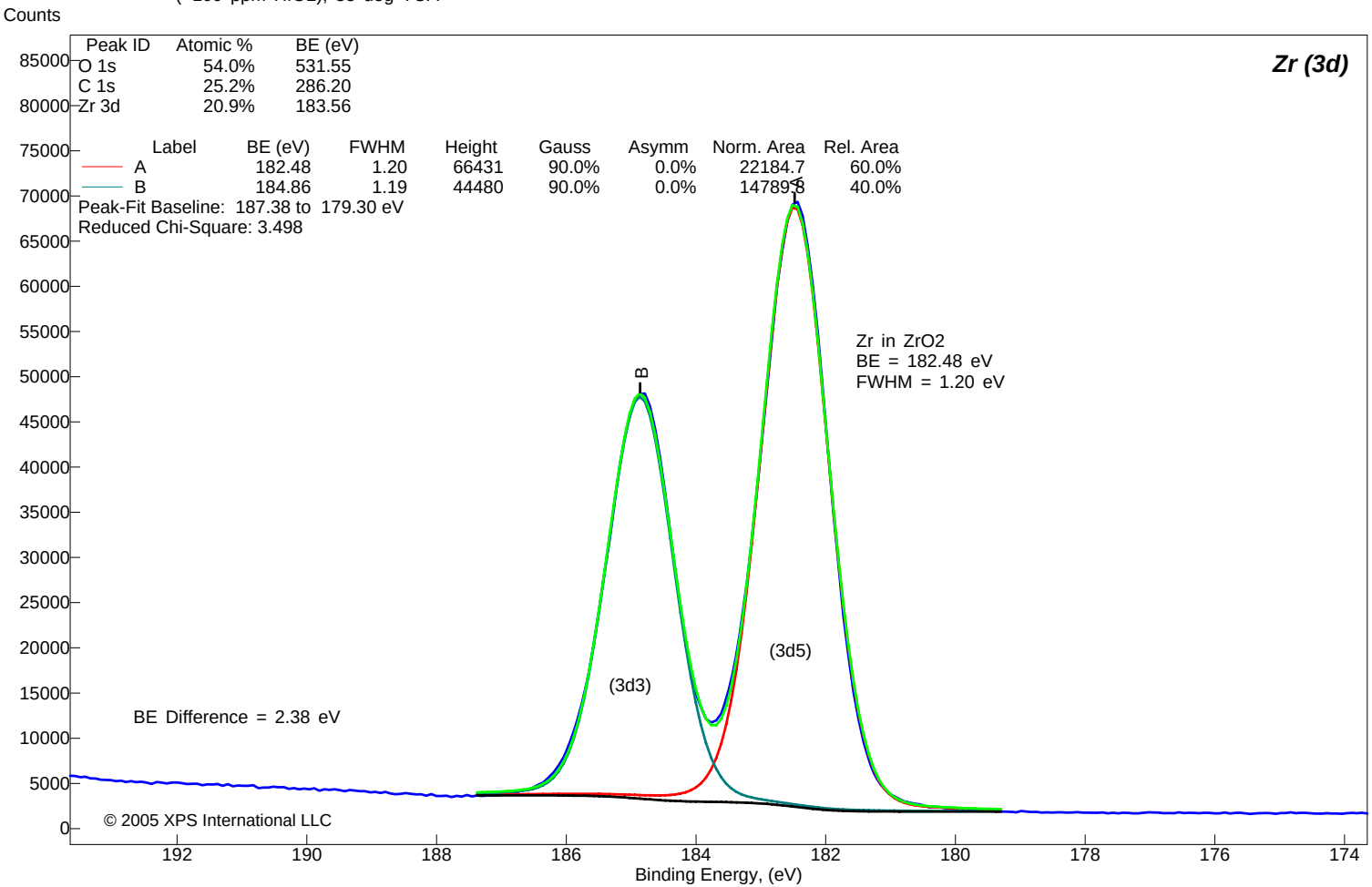


Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) Aldrich Lot# 02310BV, 3mm pellet (<100 ppm HfO2), 35 deg TOA

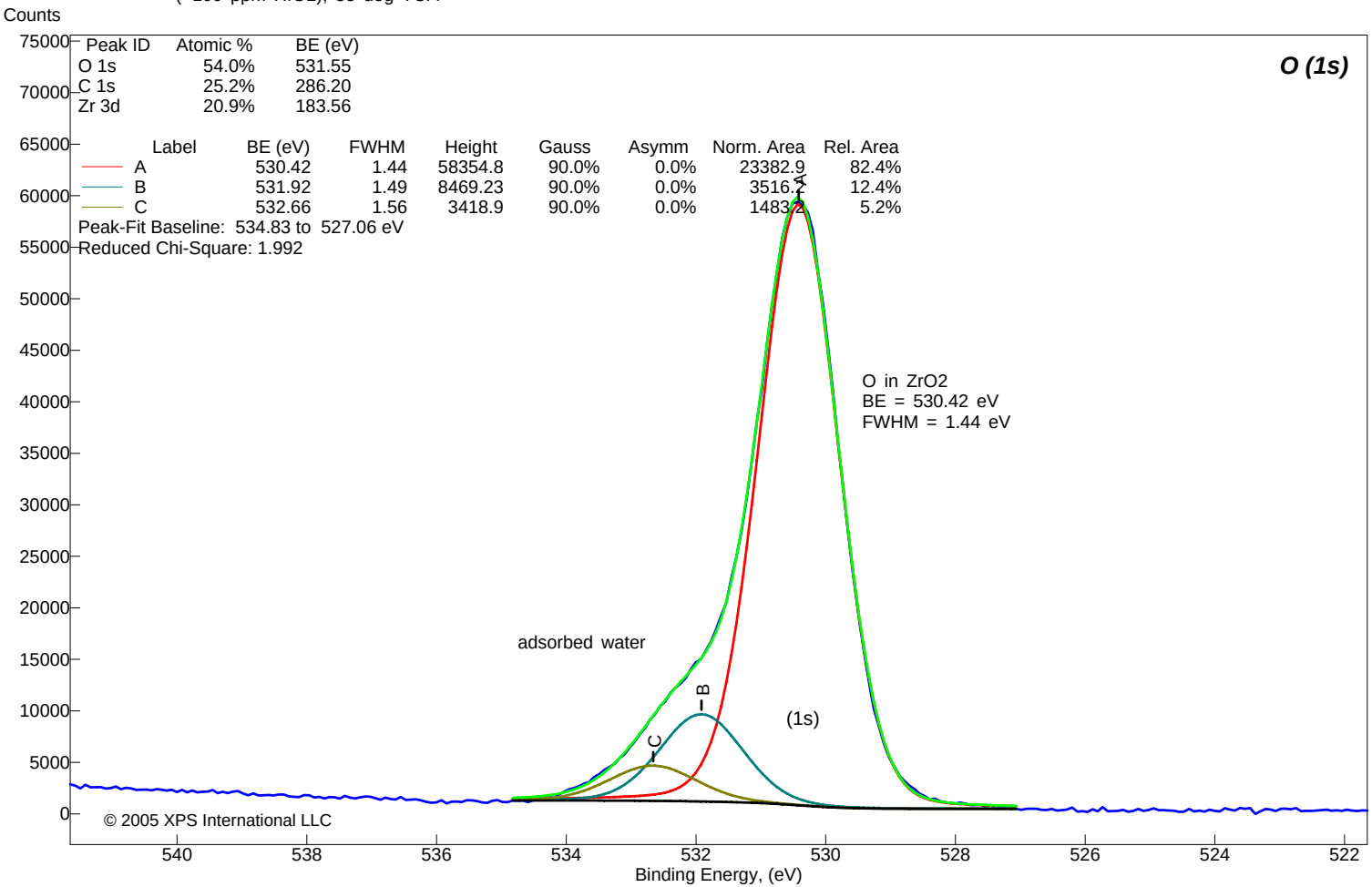


Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) Aldrich Lot# 02310BV, 3mm pellet (<100 ppm HfO2), 35 deg TOA

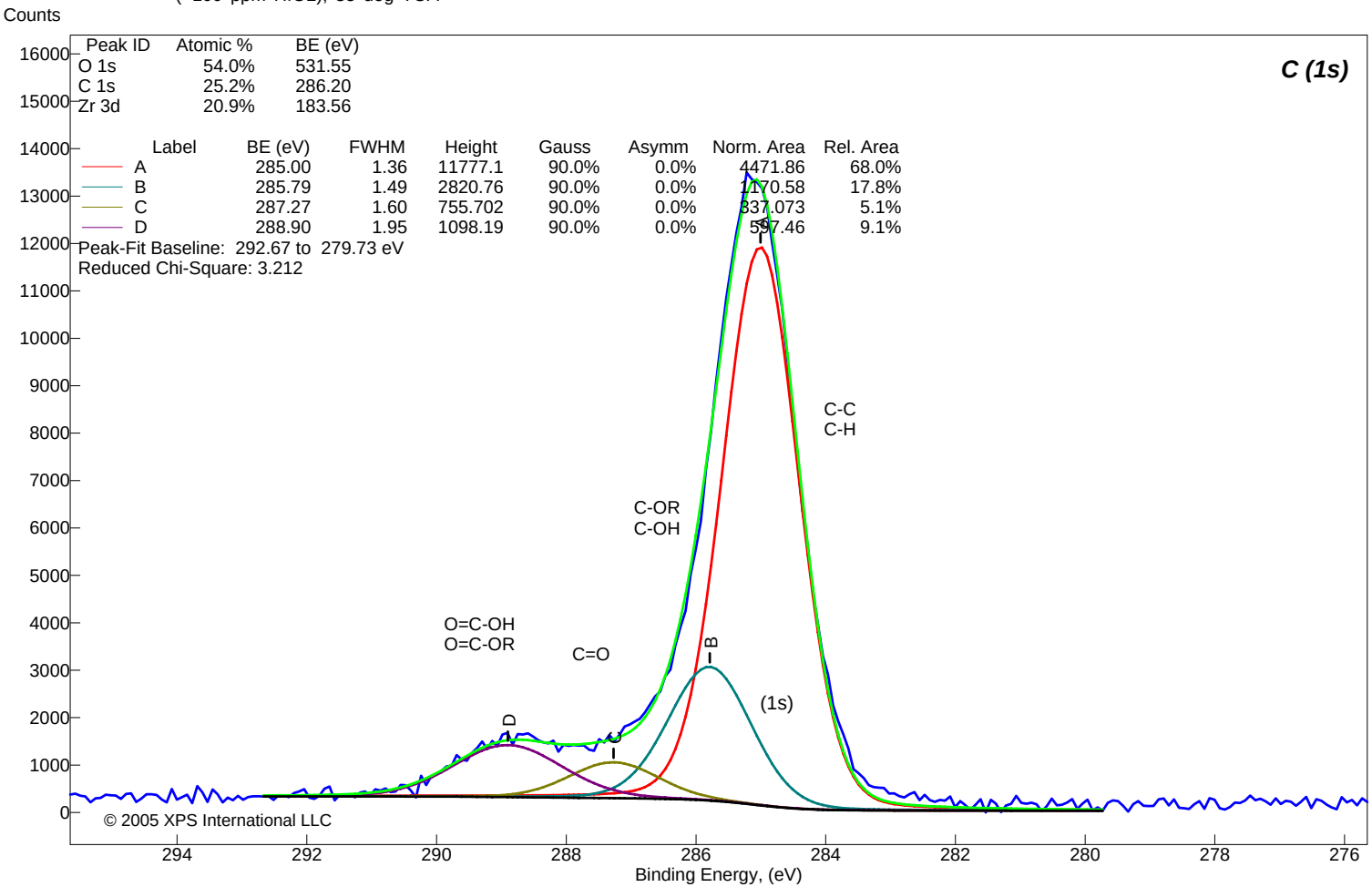


Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

ZrO_2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) Aldrich Lot# 02310BV, 3mm pellet (<100 ppm HfO2), 35 deg TOA

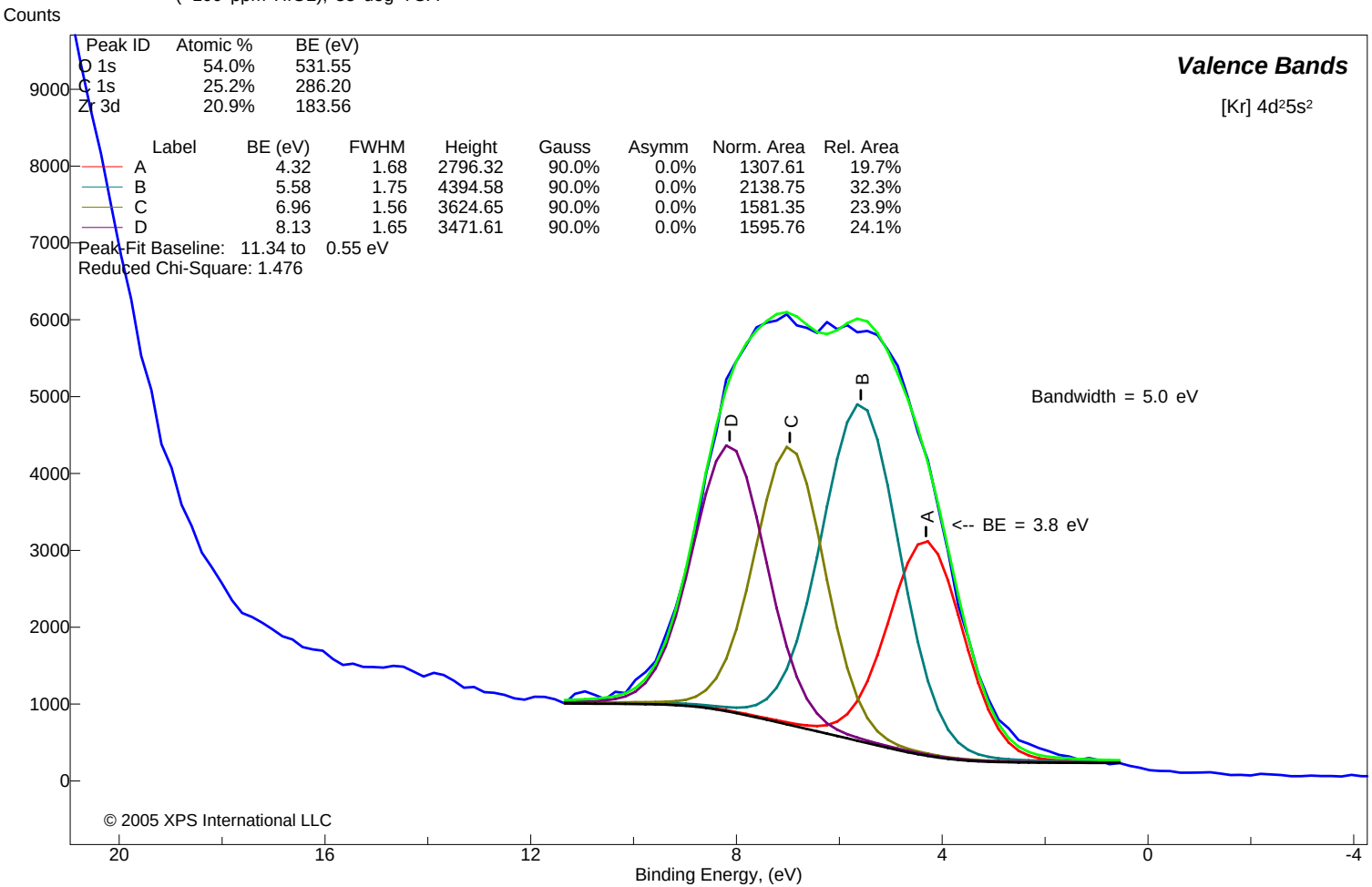


Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

ZrO_2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) Aldrich Lot# 02310BV, 3mm pellet (<100 ppm HfO2), 35 deg TOA

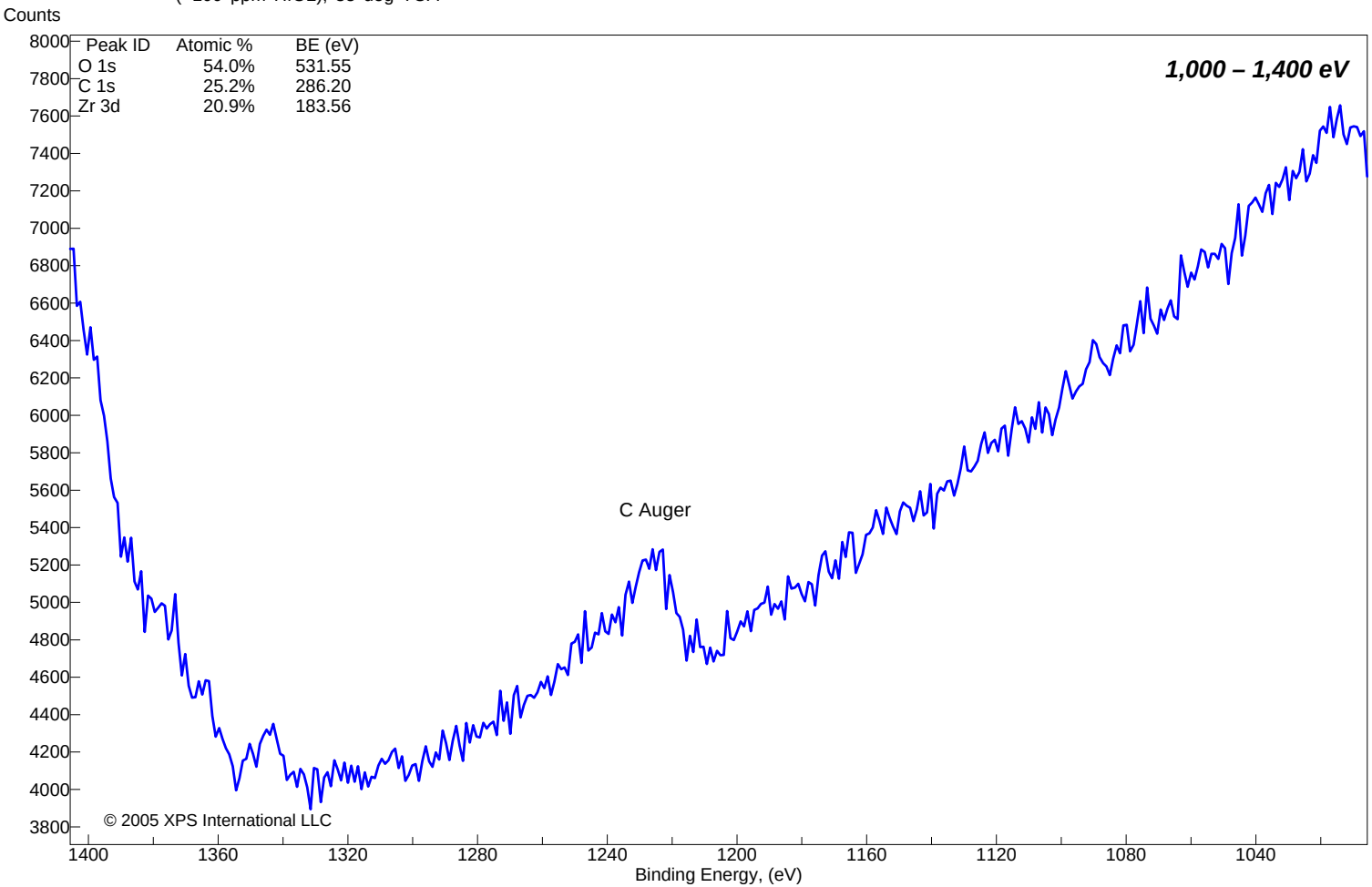


Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) Aldrich Lot# 02310BV, 3mm pellet (<100 ppm HfO2), 35 deg TOA

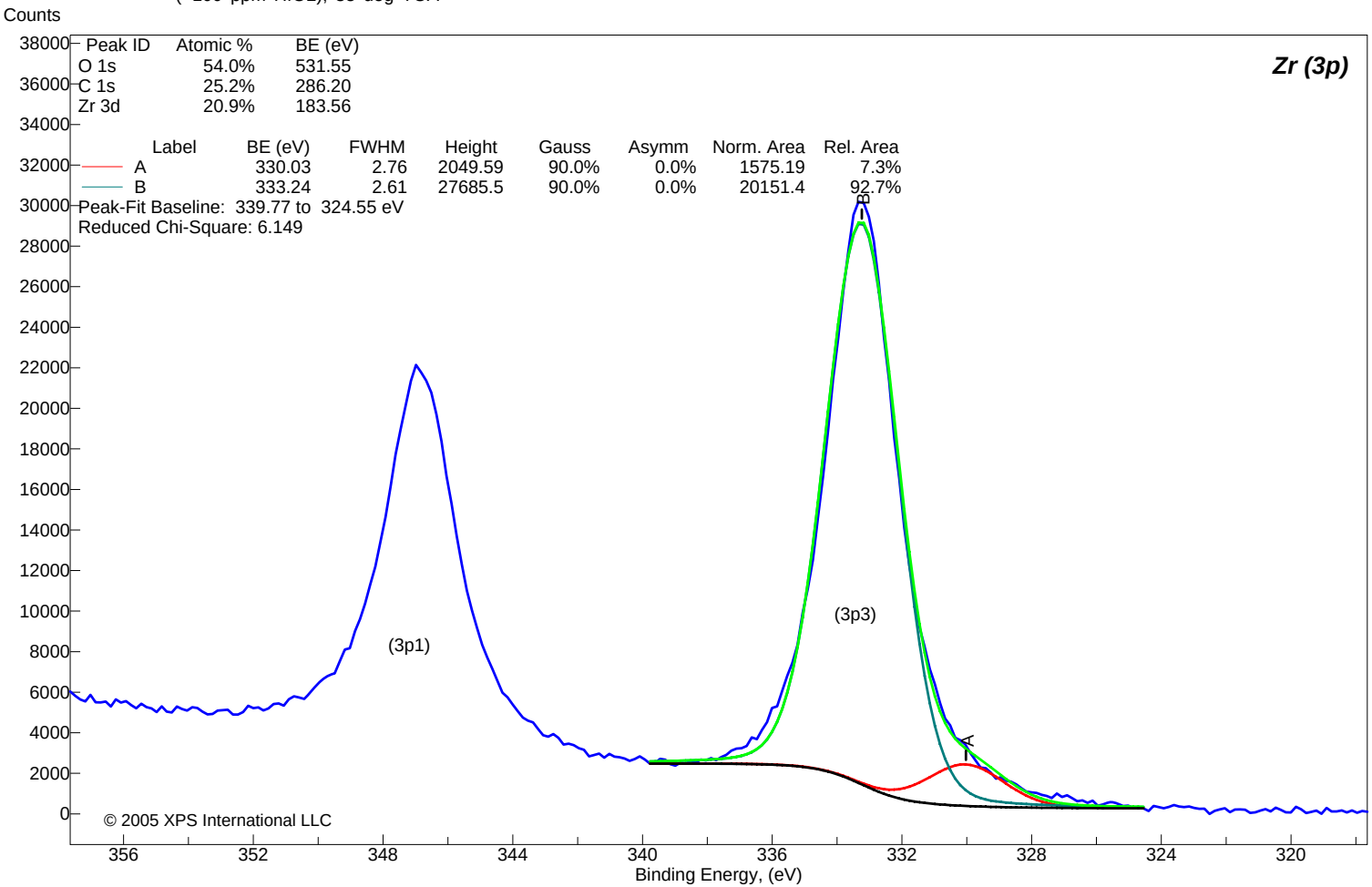


Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

ZrO_2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) Aldrich Lot# 02310BV, 3mm pellet (<100 ppm HfO2), 35 deg TOA

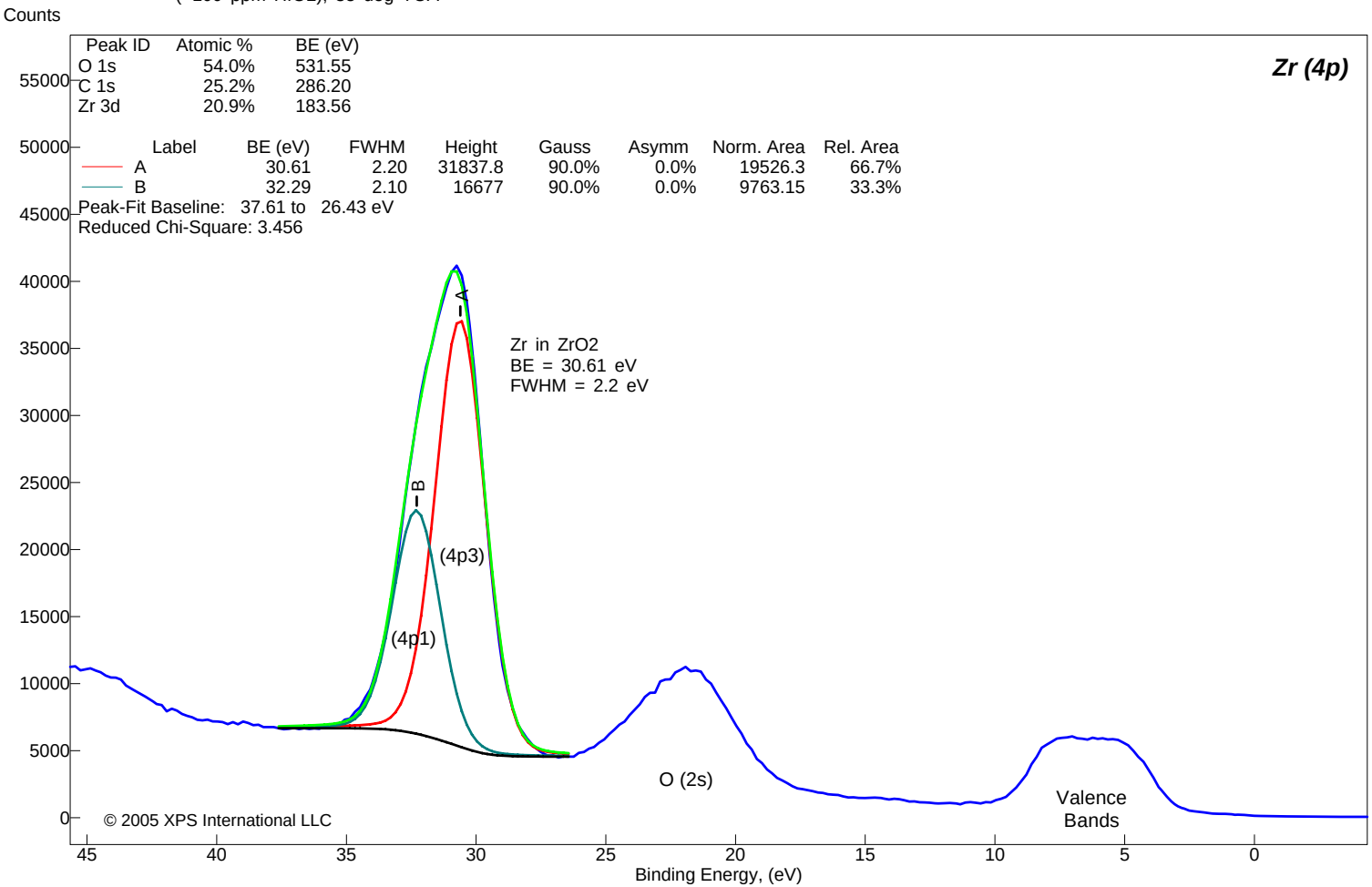


Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

Zirconium (IV) Oxide (FW = 123.22)

Sample Description: ZrO2 (99.9%) Aldrich Lot# 02310BV, 3mm pellet (<100 ppm HfO2), 35 deg TOA

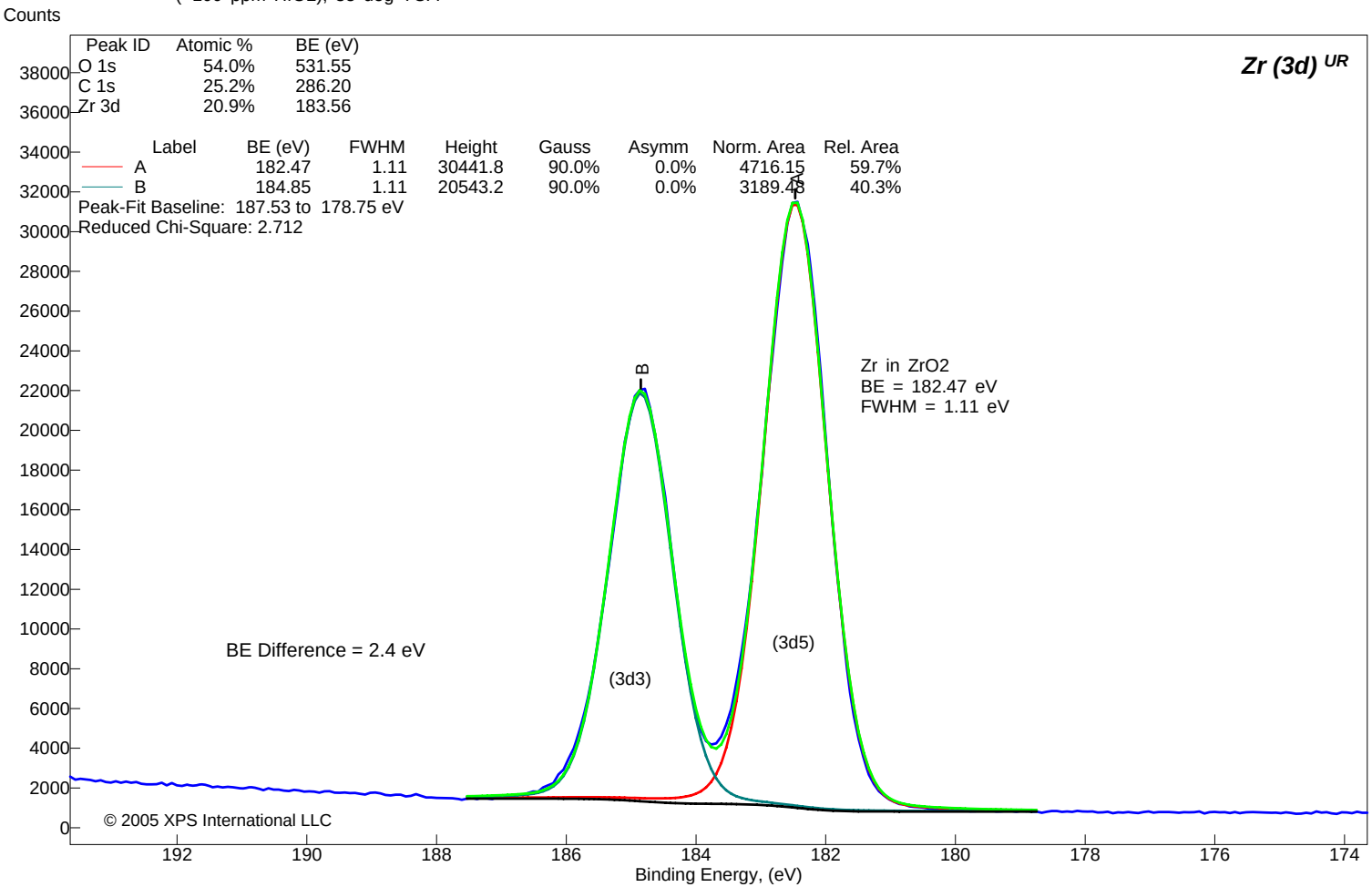
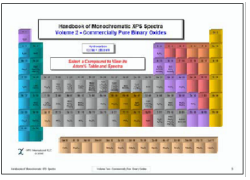
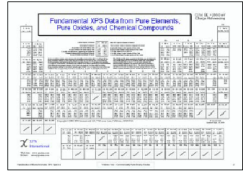


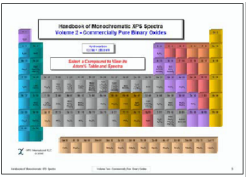
Table
Survey
M #1
O (1s)
C (1s)
VB
1,000 eV
M #2
X1
X2

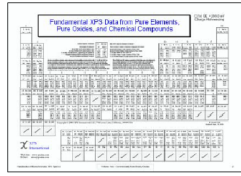




Appendices

1. Drawings of Charge Control Physics without Mesh-Screen versus with Mesh-Screen
2. Categorical List of Materials in XI Library of Monochromatic XPS Spectra
3. Alphabetical List of Materials in XI Library of XPS Spectra by Chemical Formula /Common Name
4. Contamination Caused by Handling Products/Materials with Plastic Gloves
5. Unknown Binding Energy (BE) Look-up Table for XPS Signals





Charge Control Physics without Mesh-Screen versus with Mesh-Screen

The drawings on the following two pages are crude simplifications of the complicated physics that occur when the mesh-screen device is and is not used to “control” the “necessary excess” of electrons on the surface of a non-conductor. When the necessary excess of low voltage electrons is “properly or well controlled”, the flux of electrons is understood to just match the positive holes at the surface of the non-conductive sample. This condition normally provides good to excellent charge compensation which produces the most narrow peak-widths and allow us to resolve the presence of minor species even on non-conductive samples.

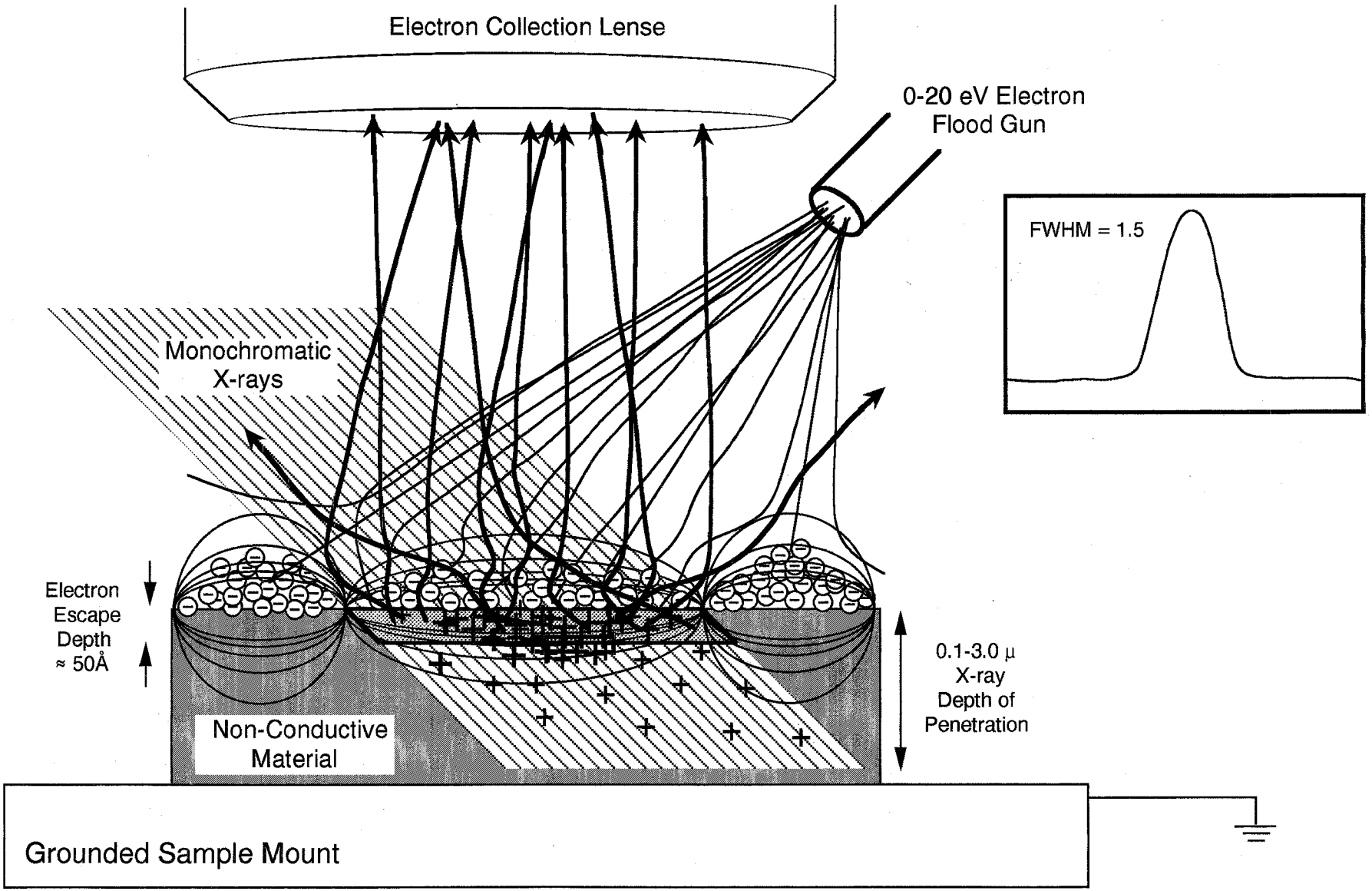
Charge Compensation of Non-Conductive Compounds

Charge compensation of non-conductive materials was handled by using the patented SSI mesh-screen together with a low voltage flood gun of electrons which used an acceleration voltage adjusted to 2-4 eV, unless otherwise noted. The mesh-screen device uses an 85% transmission electro-formed mesh made of nickel metal that is supported above the surface of the sample by mounting the mesh on a conductive metal frame that is grounded to the sample mount. To achieve good charge compensation the mesh-screen was positioned so the distance between the mesh and the surface of the sample is between 0.5-1.0 mm. When the distance between the mesh-screen and the surface of the sample is greater than 1.2 mm, the usefulness of the mesh-screen flood gun system was null. This mesh-screen method has been found to useful on a wide variety of XPS systems that use monochromatic X-rays and a source of electrons that are from a flood source or a poorly focused source of low voltage electrons.

The mesh-screen is understood to function as an electron cut-off lens with some tendency to allow incoming flood gun electrons to focus on the area being irradiated with monochromatic X-ray beam because the X-ray beam does not have a uniform flux density of the area of the beam. In effect, the mesh-screen produces a nearly uniform electric potential at the surface of the sample and allows incoming flood-gun electrons to pass through whenever they are needed.

The mesh-screen was used above every sample except for a few that were analyzed before the mesh-screen method was invented. Because the electrical nature of many of the samples was unknown until we attempted to collect data, nearly all samples were covered by the mesh-screen device. When the mesh-screen covers a conductive sample there is a very slight drop in counts because the mesh-screen captured or deflected some of the photo-emitted electrons. If ion etching is done with the mesh in place, then a slight amount of nickel appears on the ion etched sample.

Typical Charge Control without Mesh-Screen



BVCrist
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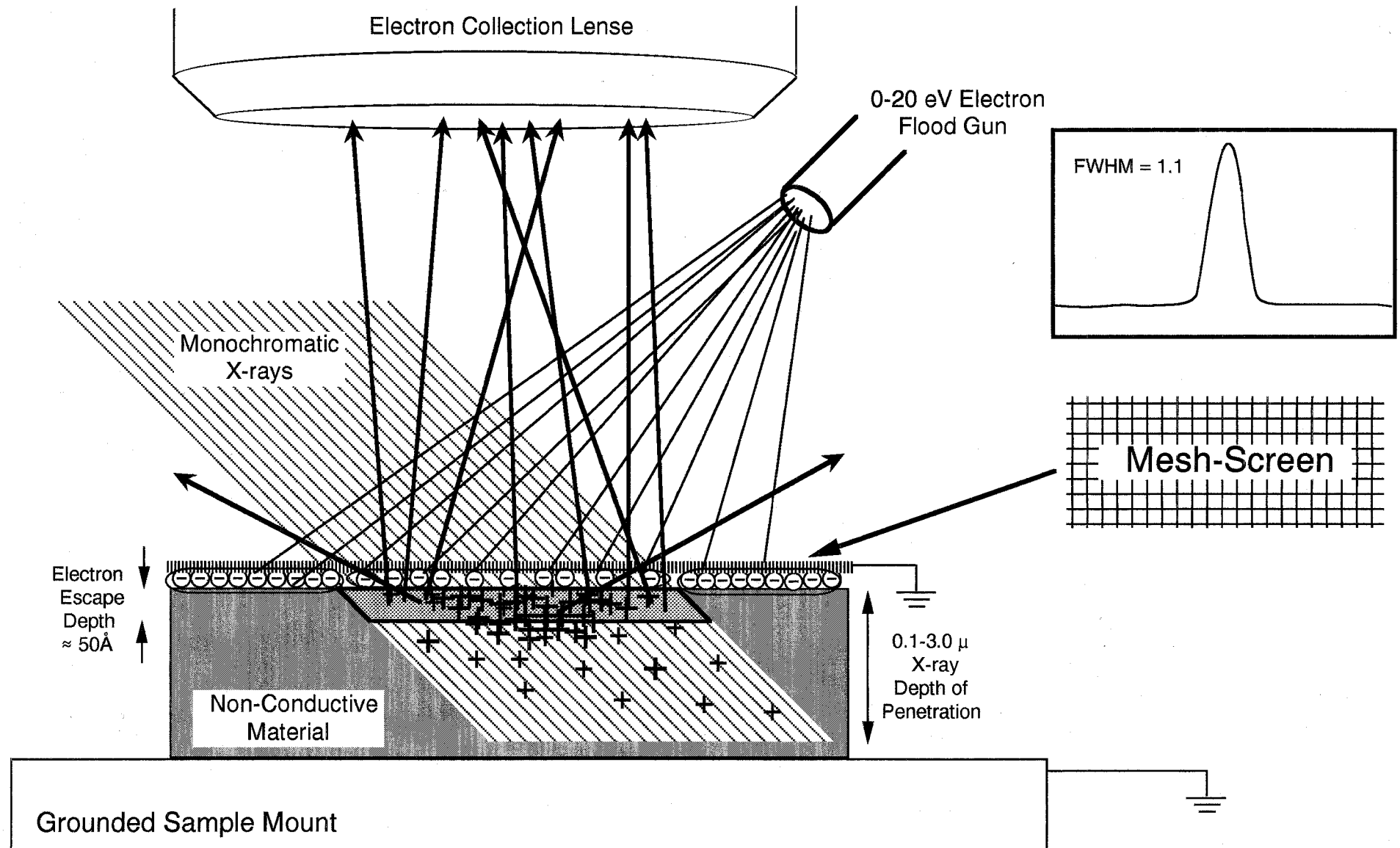
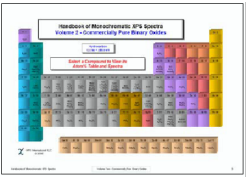
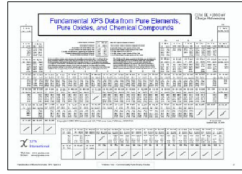
Charge Control with Mesh-Screen







Alphabetical List of Materials in the XI Library of Monochromatic XPS Spectra

Table 2, shown on the following pages, provides a list of most of the materials that were analyzed by XPS International. The resulting spectra represent the complete collection of the XI Library of Monochromatic XPS Spectra.

This list is organized, alphabetically, by the Chemical Formula or Common Name of each material. The previous section provides a list of materials by category along some details of the analysis conditions, the purpose of the data set, and experimental observations derived from the category.

Aragonite

$CaCO_3$

Native Sulfur

S^o

Cinnabar

HgS

Native Copper

Cu^o

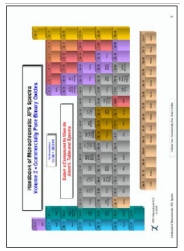
Native Gold

Au^o

Table 2. Alphabetical List of the Materials in the "XI Library of Monochromatic XPS Spectra"

These images of natural minerals and elements in the native state were scanned from photos produced by G. E. Harlow and J. J. Peters at the American Museum of Natural History.

A list of most of the chemicals and materials that were analyzed by XPS in the process of making the XI Library of XPS Spectra is shown below. It is organized alphabetically and by using Chemical Formulae (e.g. Cr_2O_3) or Common Names (e.g. PMMA, Galena, Pyrite, Poly-Ethylene (PE, HDPE), or AuCu 25:75 alloy) to identify the material.



20-CB-3 alloy
29-4-2 alloy
304 SS alloy
304 SS alloy
304L SS alloy
310 SS alloy
316 SS alloy
316L SS alloy
347 SS alloy
410 SS alloy
4140 alloy
430 SS alloy
4340 alloy
904L alloy
Adhesive Tape
Ag
Ag / AgCr / Cr / glass
Ag / PET
Ag / Si
Ag2O
Ag2S
AgO
AgOx (native oxide)
Al
Al / AlGaP / GaP
Al / AlGaSb / GaSb
Al / GaP
Al / GaSb
Al / Poly-Acrylic Acid (PAA)
Al(acac)3
Al(OH)3
Al+Pt / Zeolite
Al-1100 alloy
Al-2024 alloy
Al2O3
Al-3003 alloy

Al-5086 alloy
Al-6061 alloy
Al6x1 alloy
Al-7075 alloy
AlGaAs
AlGaP / GaP
AlGaSb / GaSb
Almandine (Fe3Al2(SiO4)3 Alaska, USA)
AlN
AlOOH
AlOx (native oxide)
AlOx / teflon
AlTi / Sb2Se3 / Bi2Te3 / Sb2Se3
Alumino-silicate
Alumitex Paper
Anatase (beta-TiO2 on Magnetite, Arkansas, USA)
Anti-Static Bag
Anti-Static Spray
Ar
Ar / B
Ar / C
Argentite (Ag2S, Guanajuato, Mex.)
As
As2O3
As2S2
As2S3
AsOx (native oxide)
Au
Au / PET
Au / Si
Au / teflon
Au2O3
AuCu 25:75 alloy
AuCu 50:50 alloy
AuCu 75:25 alloy
AuOx (native oxide)

Azurite (CuCO3:Cu(OH)2, Arizona, USA)
B
B2O3
Ba
BaCO3
Ball Bearing
BaO
BaOAc
Be
BE Calibration on Au
BE Calibration on Cu
BeAl2O4
BeO
BeOx (native oxide)
Bi
Bi2O2CO3
Bi2O3
BiOx (native oxide)
BiSrCaCuOx
BiSrCuOx
Black zeolite
BN
Bond Pad
BOx (native oxide)
Braecote Lubricant
Brookite (gamma-TiO2, Arkansas, USA)
C
C (Ar+)
C (Xe+)
C / AlOx
C / CoNi / Cr
C / In
C / Si
C / steel
C / Zeolite
C-1010 alloy

Cleaning Solution
Co
Co / NbN / Co / NbN
CO Gas Sensor
Co(acac)2
Co(acac)3
Co(OH)2
Co3O4
CoNi / Al / CoNi / Al
CoNi 25:75 alloy
CoNi 45:55 alloy
CoNi 50:50 alloy
CoNi 75:25 alloy
CoO
CoOx (native oxide)
CopperTex Paper
Copy Paper
Corrision Protectant
Corundum (Al2O3, India)
Covellite (CuS, dk blue)
Cr
Cr / glass
Cr(acac)3
Cr2O3
CrB
CrF3 Al2O3
CrMo 1.25:0.5 alloy
CrMo 2.25:1.0 alloy
CrMo 5.0:0.5 alloy
CrMo 9.0:1.0 alloy
CrN
CrO3
CrOx (native oxide)
CrSi
CsBr
CsCl

CsO2,SiO2
Cu
Cu (Ar+)
Cu / Aluminite Disk
Cu / Si
Cu / teflon
Cu(acac)2
Cu(OH)2
Cu2O
CuCl
CuCO3
CuCO3,Cu(OH)2
CuNi
CuNi (Monel) alloy
CuNi 10:90 alloy
CuNi 20:80 alloy
CuNi 30:70 alloy
CuNi 40:60 alloy
CuNi 50:50 alloy
CuNi 60:40 alloy
CuNi 70:30 alloy
CuNi 80:20 alloy
CuO
CuOx (native oxide)
Cu-Phenylcyanine
Cuprite (Cu2O, Zaire, Africa)
CuS
CuSO4
CuTi 30:70 alloy
CuTiAl 24:56:20 alloy
CuTiSi 27:63:10 alloy
CuZn 65:35 alloy
DHM powder
Diamond (C)
Diaspore (AlOOH = Al2O3-1H2O)
4,4' Dimethoxy benzophenone

Double Sided Tape
Dy
Dy2O3
E-26-1 alloy
Envelop Glue
Envelop Paper
Er
Er2O3
Eu2O3
F-255 alloy
Fe
Fe(acac)3
Fe2O3
Fe3Al2(SiO4)3
Fe3O4
FeCrMo 2%Mo alloy
FeNiMoB 40:38:4:18 alloy
FeO
FeOOH
FeOx (native oxide)
FeS2
Filter Paper
Fluoroether Lube
Food Bag
Ga
Ga2O3
GaAs
GaInAs
Galena (PbS, Missouri, USA)
GaOx (native oxide)
GaP
GaSb
Gd
Gd2O3
Ge
GeO2

GeOx (native oxide)
GeSe
GeSe2
Glove Contamination
Gold Jewelry
HA-25 alloy
Halite (NaCl + ?)
Hard Disk
Hausmannite (Mn3O4, S. Africa)
HB-2 alloy
HC-276 alloy
Hematite (alpha-Fe2O3, Arizona, USA)
Hf
Hf(acac)4
HfO2
HfOx (native oxide)
Hg
HG-3 alloy
HgO
HgS
HgTe
Ho
Ho2O3
HOPG (C)
Human Hair
HX alloy
I-600 alloy
I-625 alloy
I-750X alloy
I-800 alloy
I-825 alloy
In
In2O3
Ink on Paper
Inkjet Paper
InOx (native oxide)

InP
InSb
InSnOx
Ir
Ir:Th
IrO2
IrOx (native oxide)
K2CrO4
K2O,SiO2
K2Ti4O9
KBr
KCl
KI
KimWipe Paper
Kr+
K2CrO4
Krytox Lubricant
Kunzite (LiAlSi2O6, Aghanistan
La2O3
LaB6
Li(acac)
Li2O,SiO2
Li2O,TeO2
Li2O:TeO2
Li2WO4
LiAlSi2O6
LiCO3
LiF
Lint Free Cloth
LiOH
Loctite Glue
Lu
Lu2O3
Lubricant
LuOx (native oxide)
M-400 alloy

Magnesite (MgCO3, Washington, USA)
Magnetic Head
Magnetic Tape
Mg
Mg(acac)2
Mg(OH)2
Mg3Al2(SiO4)3
MgAl2O4
MgCO3
MgO
MgOx (native oxide)
Mn
Mn(acac)3
Mn2O3
Mn3O4
MnCO3
MnO
MnO2
MnOx (native oxide)
Mo
Mo:Ni / Al2O3
MoB
MoO2
MoO2(acac)
MoO3
MoO3 (Ar+)
MoOx (native oxide)
Mordenite Zeolite
MoS2
MoS2 (Ar+)
N-200 alloy
Na(acac)
Na2O,Cs2O,SiO2
Na2O,SiO2
Na2O,TeO2
Na2O:TeO2

Na2S2O3
Na2Si3O7
Na2W2O7
Na2WO4
NaCl
NaSiBO
Natural Graphite (C)
Nb
Nb2O5
NbC
NbO
NbO2
NbOx (native oxide)
Nd
Nd(acac)3
Ni
Ni(acac)2
Ni(OH)2
Ni,W / Al2O3
Ni3B
NiO
NiOx (native oxide)
Nitrocellulose
Nomex Fabric
Nylon 6
O+ / Cr
O+ / Hf
O+ / Nb
O+ / W
O+ / Zr
Opal (SiO2-nH2O, Mexico)
Orpiment (As2S3, Nevada, USA)
P
Pb
Pb(acac)3
Pb2O3

Pb3O4
PbCO3
PbO
PbO glass
PbO,GeO2
PbO,GeO2,PbF2
PbO:GeO2:PbF2
PbO2
PbOx (native oxide)
PbS
Pd
Pd / CeO2 / ZrO2 / Alumina
Pd:Fe 73.8:26.2 alloy
PdO
PdOx (native oxide)
Pellet Making Test
Phosphorous silicate glass
Poly(1-butene)
Poly(1-Butene) (PB)
Poly(2-chloro ethyl methacrylate)
Poly(2-hydroxy ethyl methacrylate trimethyl silane)
Poly(2-hydroxy ethyl methacrylate)
Poly(4-ethoxy styrene) (PES)
Poly(4-methyl styrene)
Poly(4-Methyl-1-pentene)
Poly(4-Vinyl phenol)-TFAA derivative
Poly(Acetal)
Poly(Acrylic acid)
Poly(Acrylic Acid) / Al (PAA)
Poly(Acrylic Acid) / Si (PAA)
Poly(Acrylonitrile) (PAN)
Poly(alpha-methyl styrene)
Poly(Amide)
Poly(Caprolactam) (Nylon 6)
Poly(carbonate)
Poly(Carbonate) (PC)

Poly(Chloro-styrene)
Poly(di-methyl siloxane)
Poly(Ether Ether Ketone) (PEEK)
Poly(Ethyl acrylate)
Poly(ethyl methacrylate)
Poly(Ethylene Glycol) 4000
Poly(Ethylene Oxide) (PEO)
Poly(ethylene terephthalate) PET
Poly(Ethylene tetra-fluoro ethylene)
Poly(Ethylene)
Poly(Imide) (Kapton)
Poly(methyl acrylate)
Poly(Methyl Methacrylate) (PMMA)
Poly(Methylene di-isocynate/butane diol) copolymer
Poly(Methylene di-isocynate/butane diol/propane diamine)
Poly(Methylene di-isocynate:Propane diamine) copolymer
Poly(Nitrocelluose) Filter Paper
Poly(octyl-styrene)
Poly(para hydroxystyrene)
Poly(Phenylene sulfide)
Poly(Propylene Glycol) 2000
Poly(Propylene)
Poly(Styene) (PS)
Poly(Sulfone)
Poly(tetra methylene glycol) 2000
Poly(Tetrafluoroethylene) (Teflon)
Poly(Vinyl acetate)
Poly(vinyl alcohol)
Poly(Vinyl Chloride) (PVC)
Poly(Vinyl methyl ketone)
Poly(Vinyl napthalene)
Poly(Vinyl pyridine)
Poly(Vinylidene di-Fluoride) (PVDF)
Polyester
POx (native oxide)
Pr

Pr2O5
Printer Paper
Pt
Pt / Zeolite
PtO2
PtOx (native oxide)
Pyrex Glass
Pyrite (FeS2, Mexico)
Pyrope (Mg3Al2(SiO4)3, Arizona USA)
Race Track Bearing
RbOAc
Re
Re2O7
Realgar (As2S2 Nevada, USA)
ReOx (native oxide)
Resin
Rh
Rh2O3
Rhodochrosite (MnCO3, Argentina)
RhOx (native oxide)
Rice Leaf
Rice Straw Paper
Ru
RuO2
RuOx (native oxide)
Rutile (alpha-TiO2) on Hematite, Bahia, Brazil)
Rutiled-Quartz (TiO2-SiO2 , Brazil)
S
Sapphire (Al2O3, Sri Lanka)
Saran Food Wrap
Sb
Sb2O3
Sb2O5
SbOx (native oxide)
SbTe
Sc

Sc2O3
Scheeite (CaWO4)
ScOx (native oxide)
Se
SeOx (native oxide)
Si
Si (Ar+)
Si/teflon
Si3N4
Si3N4 [SiNO] (Ar+)
Si3N4+MgAl204+B2O3
SiCN / Si
Silicone Oil
Silicone Release
Silicone Remover
Silver Saver paper
SiO
SiO2
SiO2 / Si
SiO2 / Si / teflon
SiO2 / teflon
SiO2 / TiSi / Si /Si
SiO2-nH2O
SiOx (native oxide)
SiOx / Si / teflon
Sm
Sm2O3
Sn
SnO
SnO2
SnO2 (Ar+)
SnOx (native oxide)
Soda-Lime Glass
Spider Web
Spinel (MgAl2O4, Sri Lanka)
SrCO3

SrO
SrTiO3
Static Spray
System Check Ag
System Check Au
System Test
System Test (Cu or Ag)
Ta
Ta2O5
TaC
Talc Zeolite
Tantalite
Tantalite (Nb? Ta?, Minas Gerais, Brazil)
TaOx (native oxide)
TaS2
Tb
Tb3O7
TbF3
Te
teflon
TeO2
TeO2:PbO:PbF2
TeOx (native oxide)
Texwipe Cloth
Thermal Paper
Ti
Ti GR-02 alloy
Ti GR-07 alloy
Ti GR-12 alloy
Ti2O3
TiN
TiN/Si
TiO
TiO2
TiO2 (Ar+)
TiO2 / SiO2 / TiO2 / SiO2

TiO2-SiO2
TiOx (native oxide)
TiSi
TiVAl alloy
Tl
Tl(acac)
Tl2O3
TlOx (native oxide)
Tm
Tm2O3
Tokusa Plant
Transmission Test Cu
V
V2O3
V2O5
V2O5 cat.
VC
VO2
VOx (native oxide)
W
Water Residue
Wax Paper
WB
WC8-15-VII-1,2% BIOMER
Wheat Straw Plant
White Zeolite
WO3
WO3 (Ar+)
Wood`s metal alloy
WOx (native oxide)
Xenotime (YPO4)
Y
Y2(CO3)2
Y2O3
Y2O3 (Ar+)
Yb

Yb2O3
YBaCuOx
Yeast
YOx (native oxide)
YPO4
Zeolite
Zeolite MS-5A
Zeolite X
Zeolite Y
Zircon (ZrSiO4, Brazil)
Zn
Zn(acac)2
Zn+ / Si
ZnO
ZnOx (native oxide)
ZnS
ZnSe
Zr
Zr(acac)4
Zr+ / Fe
Zr+ / FeCr
ZrO2
ZrO2 (Ar+)
ZrO2,SiO2
ZrOx (native oxide)
ZrSiO4

Contamination Caused by Handling Products/Materials with Plastic Gloves

The data in the following table (Table 3) represent some of the types of contamination that occur when a material or a product is handled with various types of plastic gloves. The reader is recommended to use caution when handling any sample with gloves and to perform a similar analysis on any gloves that are used in the lab.

Contamination Caused by Gloves

Un-gloved hands will contaminate a valuable product with various organic oils, NaCl, water and other chemicals, which a worker has touched accidentally or is wearing as a cosmetic. To avoid such contamination, the worker is normally required to wear gloves.

We have tested for contamination from a variety of gloves by wearing each glove and touching a piece of aluminum foil. We analyzed the surface of the foil as received and after touching. (We have not analyzed the surfaces of the gloves.)

The data in this table tell us that various gloves may cause contamination. The main contaminants appear to be organic oils, silicone oil and various inorganic salts. These contaminants are probably caused by the process of manufacturing the gloves and the actual chemical content of the gloves.

A variety of organic chemicals are used as slip agents (e.g. erucamide) or plasticizers (e.g. organic acids). Silicone oil is used as a mold release agent. Various inorganic salts are used to avoid caking of the polymeric powders which are used to make gloves. Inorganic salts are also be used to keep the hand dry while inside the glove.

From these data we can see that gloves are a potential source of contamination. The level of contamination, which may change from one box to another, depends on the manufacturer and his manufacturing techniques, which may change from month to month or perhaps week to week.

Sample Description	Elemental Composition of Glove Contaminated Surface										
	Al	C	O	Si	N	Na	Cl	S	Ca	F	Zn
Control: Un-Touched Aluminum Foil #1	29.	29.	41.	----	----	----	----	----	----	----	----
Control: Un-Touched Aluminum Foil #2	30.	21.	48.	----	0.3	----	----	----	----	----	----
Human Fingerprint on Aluminum Foil	6.6	76.	16.	0.6	0.6	0.7	0.1	----	----	----	----
Glove #1 (plastic coated white nylon, opaque)	23.	33.	40.	3.8	----	----	0.6	----	----	----	----
Glove #2 (off-white latex, translucent)	22.	40.	34.	2.1	----	0.4	----	----	----	0.3	----
Glove #3 (yellow latex, opaque)	2.2	50.	23.	24.	----	----	0.3	----	----	----	----
Glove #4 (pink, textured PE, translucent)	20.	53.	26.	----	0.6	----	----	----	----	----	----
Glove #5 (pink latex, translucent)	19.	42.	33.	5.8	----	0.3	----	----	----	----	----
Glove #6 (yellow latex, opaque)	23.	42.	33.	----	0.6	0.5	----	1.1	----	----	----
Glove #7 (off-white vinyl, opaque)	27.	41.	32.	----	----	0.5	----	----	0.1	----	----
Glove #8 (striped white nylon, opaque)**	29.	22.	47.	1.4	0.1	0.3	----	----	---	----	----
Glove #9 (black conductive rubber, opaque)	14.	53.	32.	0.9	0.3	----	----	----	----	----	----
Glove #10 (white latex, translucent)	7.4	54.	26.	10.	----	0.2	0.8	1.1	----	----	----
Glove #11 (yellow latex, opaque)	21.	36.	39.	2.9	0.4	----	----	----	0.1	----	0.3
Glove #12 (clear plastic, transparent)	17.	53.	29.	----	1.0	0.2	----	----	----	----	----
Glove #13 (white plastic, translucent)	27.	25.	47.	0.4	0.5	----	0.1	----	----	----	----

**Used in a Class 10 Clean Room.

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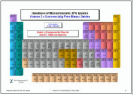
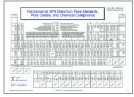




Unknown Binding Energy (BE) Look-up Table for XPS Signals

This table (Table 4) can be used to identify weak signals that may be caused by low levels of some unexpected contamination. Before assigning the presence of a new and unexpected contamination, the analyst should try to attribute weaker signals to those elements that are known to be present within the sample or expected on the sample as probably contaminants.

This table also includes chemical state assignments. As always when assigning a chemical state, the analyst must be able to explain a sensible reason why that state or chemical species is present. For critical assignments, the analyst must collect reference spectra from materials known to be pure or to directly represent the materials being analysed.

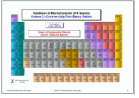


Table 4. BE Lookup Table for Signals from Elements and Common Chemical Species

1.0	Bi	6p1	3.9	Pt	5d	10.0	P	3p	18.0	At	6s	24.0	Kr	4s	34.0	K	3s	44.0	Ra	6s	52.0	Tm	5s	65.7	V	3s
1.0	Ce	4f	4.0	Ir	5d	10.0	Ti	4s	18.0	Ce	5p	24.0	Sn	4d	35.0	Re	5p3	44.0	U	6s	52.3	Yb	5s	66.0	Ni	3p
1.0	Co	3d	4.0	Pm	4f	10.0	V	4s	18.0	Pr	5p	25.0	Th	6p1	35.2	Mo	4p	44.4	Y	4s	52.6	Fe	3p	66.0	Pt	5p1
1.0	Cr	3d	4.5	Ag	4d	10.0	Zr	5s	18.1	Hf	Ntv Ox	26.0	Bi	5d3	35.2	W	Na2WO4	45.0	Ta	5p1	53.0	Sn	loss	67.8	Ta	5s
1.0	Fe	3d	4.8	Dy	5d	10.5	Bi	6s	18.2	C	2s	26.0	He	1s	35.3	Y	loss	45.1	As	2O3	53.4	Os	4f5	68.0	Ra	5d
1.0	Ga	4p	5.0	B	2p	10.7	Cd	4d5	18.4	Sr	4p	26.0	Rn	6s	35.8	W	O3	45.5	As	Ntv Ox	54.0	Os	5p1	68.0	Tc	4s
1.0	Hf	5d	5.0	Br	4p	11.0	Kr	4p	18.7	Ga	3d5	26.1	Lu	5p	36.0	Ce	5s	45.7	Ge	loss	54.2	Se	CdSe	68.5	Br	3d5
1.0	In	5p	5.0	Ca	3d	11.0	Rn	6p	18.8	Ga	3d	26.8	Ta	2O5	36.0	Gd	5s	46.0	Re	5p1	54.5	Se	GeSe	68.5	Br	KBr
1.0	Na	3s	5.0	Er	4f	11.0	Sc	4s	18.9	Ga	3d3	26.8	Zr	4p	36.6	Sr	4s	46.3	Ga	loss	54.9	Se	3d5	68.8	Cd	4p
1.0	Os	5d	5.0	Po	6p	11.1	Cs	5p3	19.0	Eu	5p	27.0	Br	4s	36.7	V	3p	46.8	Re	2O7	54.9	Li	1s	69.0	Br	3d
1.0	Pb	6p	5.3	Se	4p	11.6	Cd	4d3	19.0	Nd	5p	28.2	Sc	3p	37.0	W	5p3	46.8	W	5p1	54.9	Li	OH	69.5	Br	3d3
1.0	Sn	5p	5.5	Cl	3p	12.0	Cs	5p	19.0	Pb	5d5	28.6	In	loss	37.5	Hf	5p1	47.0	Mn	3p	54.9	Se	3d	70.0	Re	loss
1.2	Yb	4f7	5.8	Au	5d	12.0	Po	6s	19.0	Ra	6p	28.8	Rb	4s	38.0	Pm	5s	47.0	Rh	4p	55.2	Se	GeSe2	71.0	Pt	4f7
1.4	Pd	4d	6.0	Ta	5d	12.0	Te	5s	19.0	Sm	5p	29.0	Dy	5p1	38.0	Pr	5s	47.9	Ru	4p	55.3	Li	CO3	71.8	Mg	loss
1.4	Rh	4d	6.0	Y	4d	12.0	Tl	5d5	19.1	Ga	Sb fract	29.0	Er	5p	38.3	Sn	loss	48.0	Dy	5s	55.6	Nb	4s	72.6	Pt	4f
2.0	Cd	5p	6.2	Hg	5d	12.6	Cs	5p1	19.4	Ga	AlAs etch	29.0	Lu	5p	39.0	Eu	5s	48.0	Rn	5d	55.7	Se	3d3	72.7	Al	2p3
2.0	Mg	3s	6.9	Eu	4f	13.0	Tl	5d	19.5	N	2s	29.1	Ge	3d5	39.0	Nd	5s	48.0	Sb	loss	56.8	Au	5p3	72.9	Al	2p
2.0	Mo	4d	7.0	O	2p	13.2	Rb	4p	19.7	Ga	P fract	29.2	F	2s	39.0	Tc	4p	48.5	I	4d	56.8	Lu	5s	73.1	Tl	5p3
2.0	Nb	4d	7.0	Sm	4f	13.2	Rb	4p	19.7	Ga	As fract	29.4	Ge	3d	39.5	Tm	5p	49.5	Ho	5s	57.4	Er	5s	73.2	Al	2p1
2.0	Nd	4f	7.0	Sn	5s	14.0	Ne	2p	20.0	U	6p	29.5	Ho	5p1	40.0	At	5d	49.5	Mg	CO3	58.0	Ag	4p	73.8	Al	N
2.0	Ni	3d	7.0	Xe	5p	14.0	Sc	3d	20.2	Zn	loss	29.7	Ge	3d3	40.0	Ba	5s	49.6	Mg	(OH)2	58.0	Fr	5d	74.0	Au	5p1
2.0	Pr	4f	7.1	Lu	4f7	14.2	Hf	4f7	20.5	Gd	5p	30.2	Ge	Se	40.0	In	loss	49.6	Mg	2p3	58.0	Hg	5p3	74.2	Cr	3s
2.0	Sb	5p	7.1	Tb	4f	15.0	Fr	6p	20.7	Ga	2O3	30.3	Na	2p	40.0	Tb	5s	49.7	Mg	O	58.1	W	loss	74.3	Al	2O3
2.0	Sc	4p	7.7	Gd	4f	15.0	H	1s	21.0	Pb	5d3	30.9	Nb	4p	40.1	Te	4d	49.8	Mg	2p	58.2	Ti	3s	74.3	Al	2O3-nH2O
2.0	Tc	4d	7.8	Dy	4f	15.0	Hf	4f	21.6	Ta	4f7	30.9	Pb	loss	40.2	Re	4f7	49.9	Mg	2p1	58.3	Te	loss	74.4	Pt	4f5
2.0	Ti	3d	8.0	At	6p	15.0	Rb	4p1	21.8	Tb	5p	31.0	Hf	5p3	41.0	Ne	2s	50.0	Mg	CO3	58.6	Ag	4p	74.4	Al	(OH)3
2.0	V	3d	8.0	S	3p	15.0	Tl	5d3	22.0	Dy	5p3	31.0	Po	5d	41.0	Sm	5s	50.0	Sr	loss	58.9	Y	loss	74.9	Cu	3p
2.0	Yb	4f	8.3	Ho	4f	15.7	Cl	3s	22.0	Pm	5p	31.3	W	4f7	41.2	Re	4f	50.3	Zr	4s	59.0	Co	3p	74.9	Se	loss
2.0	Zr	4d	8.3	Lu	5d	15.9	Hf	4f5	22.3	Ar	3s	31.5	Ge	Se2	41.4	Re	Ntv Ox	50.4	Mg	NtvOx1	59.2	As	loss	75.0	Cs	4d5
2.5	Yb	4f5	8.4	Lu	2O3	15.9	I	5s	22.7	Ta	4f	31.7	Sb	4d	41.5	As	3d5	50.7	Os	4f7	60.8	Ir	4f7	75.1	Pt	O2-nH2O
2.6	Te	5p	8.5	Tm	4f7	16.0	K	3p	23.0	Cs	5s	32.1	Ga	loss	41.8	As	3d	50.7	Pd	4p	61.0	Mg	loss	75.1	W	5s
2.8	Cu	3d	8.6	Lu	4f5	16.0	P	3s	23.1	O	2s	32.3	W	4f	42.0	As	S	50.7	Sc	3s	62.0	Ir	4f	75.5	Al	Ntv Ox
2.8	Mn	3d	8.9	Ar	3p	16.0	S	3s	23.3	Ho	5p3	32.4	Ti	3p	42.0	Th	6s	50.9	Mg	reoxid	62.0	Ir	O2	76.0	Cs	4d
2.8	Re	5d	9.0	F	2p	16.9	In	4d	23.3	Y	4p	32.6	Ta	5p3	42.1	Ca	3s	51.0	Ir	5p3	62.0	Ir	5p1	77.8	Ni	loss
2.8	Si	3p	9.0	Ru	4d	17.0	La	5p	23.4	Ta	S2	33.0	La	5s	42.1	Cr	3p	51.0	Mg	NtvOx2	62.0	Mo	4s	78.3	In	4p
2.8	W	5d	9.0	Sb	5s	17.0	Th	6p3	23.5	Ca	3p	33.2	Ge	O2	42.2	As	3d3	51.4	Os	4f	62.0	Xe	4d	79.0	Cs	4d3
3.0	Ge	4p	9.0	Si	3s	17.0	Xe	5s	23.5	Yb	5p	33.4	Lu	5p	42.7	Re	4f5	51.5	Pt	5p3	62.3	Hf	5s	80.0	Ru	4s
3.0	I	5p	9.1	As	4p	17.1	Hf	O2	23.8	Bi	5d	33.5	W	4f5	42.7	Ta	loss	51.5	Mg	reoxid	62.7	Ir	Ntv Ox	80.7	Rh	4s
3.0	Pb	6s	9.7	Zn	3d	17.7	Pb	5d	24.0	Ta	4f5	33.8	Ge	Ntv Ox	43.0	As	2S3	51.7	Re	loss	63.3	Na	2s	81.0	Hg	5p1
3.2	Bi	6p3	10.0	Ba	5p	17.9	Ga	InAs (ar)	24.0	Bi	5d5	34.0	Fr	6s	44.0	Os	5p3	51.9	Mg	NtvOx3	63.8	Ir	4f5	81.8	Re	5s

Table 4 (cont.) BE Lookup Table for Signals from Elements and Common Chemical Species

82.0	Br	loss	101.8	Si	Almand.	119.4	Ga	loss	137.8	Pb	2O3	158.9	Y	2(CO3)3	181.0	Ge	3s	204.1	Nb	NbO	235.3	Mg	Auger
82.0	Mn	3s	101.9	Hg	4f	119.4	Tl	CO3	137.8	Se	Auger	159.2	Bi	Ntv Ox	181.1	Zr	3d3	205.0	Nb	3d3	237.0	Pm	4p3
82.7	Pb	5p3	102.0	Pt	5s	120.0	Hg	5s	138.3	Pb	4f	159.6	Ho	4d5	181.2	Br	3p3	205.1	S	loss	237.6	Ta	4d3
84.0	Au	4f7	102.0	Si	3N4	120.0	Tl	4f	138.5	Ge	loss	160.0	Bi	5s	182.0	Br	3p	205.8	Lu	4d3	237.9	Rb	3p3
84.0	Ba	4d3	102.6	Si	O	121.0	Pm	4d	138.8	Pb	Ntv Ox	161.2	S	PbS	182.0	Fr	5p1	206.1	Nb	NbO2	238.0	Cs	4s
84.7	Ba	4d	102.9	Zn	loss	121.1	I	4p	139.0	Pb	CO3	161.3	Ho	2O3	182.1	Yb	4d5	207.0	Ce	4p3	238.0	Rn	4f
85.0	Au	4f	103.0	Ga	3p	122.0	Ge	3p3	139.0	Xe	4p	161.5	S	CuS, TaS2	182.4	Zr	O2	207.0	Xe	4s	238.9	Mo	loss
85.0	Th	5d5	103.0	Ga	3p3	122.1	Tl	4f5	139.5	Zn	3s	161.7	Se	3p3	182.8	Er	Auger	207.3	P	loss	241.8	Ar	2p3
86.0	Ba	4d5	103.0	Pt	loss	122.4	Cu	3s	140.0	Fr	5p3	161.9	S	HgS	183.7	Si	loss	207.4	Nb	Nb2O5	242.0	Ar	2p
86.9	Kr	3d5	103.0	Si	O2	122.4	In	4s	140.3	Gd	4d5	162.2	S	MoS2	184.0	Po	4f	207.4	Nb	Ntv Ox	243.1	W	4d5
87.2	Kr	3d	103.0	U	5d3	127.0	Rn	5p3	140.7	As	3p3	162.3	Bi	4f5	184.9	Yb	2O3	208.0	Kr	3p3	243.9	Ar	2p1
87.7	Au	4f5	103.5	Si	O2-nH2O	128.2	Eu	4d5	141.2	Gd	2O3	162.4	S	Na2S2O3	185.3	S	loss	210.0	At	4f	245.0	Nd	4p1
88.0	Al	loss	103.7	Al	loss	128.3	Tl	loss	141.7	Pb	4f5	162.6	S	FeS2	185.5	I	4s	210.8	Hf	4d5	248.0	Ba	4s
88.1	Au	2O3	103.9	Hg	4f5	128.6	P	InP etch	142.0	As	3p	163.9	S	2p3	187.8	Br	3p1	210.9	Dy	Auger	248.0	Rb	3p1
88.2	Kr	3d3	104.0	La	4d	129.0	Ge	3p1	145.9	Tb	4d5	164.0	Rn	5p1	187.9	B	CrB	213.0	B	loss	249.6	S	loss
88.2	Pd	4s	104.0	Po	5p3	129.0	P	InP etch	146.0	Sr	loss	164.0	S	2p	188.0	B	1s	213.0	La	4p1	250.0	Sm	4p3
88.3	Zn	3p	106.3	Pb	5p1	129.0	Sm	4d	147.0	As	3p1	164.0	Sr	loss	188.0	B	MoB, LaB6	214.0	Rn	5s	253.0	Mo	loss
89.0	Os	5s	107.0	Ga	3p1	129.3	P	GaP etch	148.0	At	5p1	165.1	S	2p1	188.1	B	WB	217.5	Cl	loss	253.0	Tc	3d
89.1	Mg	2s	108.0	Au	5s	130.0	Be	loss	148.0	Pb	5s	166.6	S	Na2SO3	188.2	B	Ni3B	218.0	Pr	4p3	253.0	Tc	3d5
90.6	Sn	4p	109.7	Rb	3d5	130.0	Ho	Auger	148.5	Tb	F3	167.3	Er	4d5	188.9	B	Ntv Ox	220.5	Se	Auger	254.0	Ra	5s
91.0	Fe	3s	109.7	Rb	OAc	130.1	P	2p3	148.8	Al	loss	167.3	Se	3p1	189.0	P	2s	221.3	Hf	4d3	255.0	Br	3s
92.8	Bi	5p3	109.9	Cd	4s	130.6	P	2p	149.8	Pb	loss	167.6	Si	loss	189.2	Tm	Auger	223.0	Ce	4p1	255.0	Eu	4p3
93.0	Th	5d3	110.0	Ce	4d	131.4	P	2p1	149.9	P	loss	168.5	Er	2O3	190.8	B	N	225.7	As	3s	255.0	Pm	4p1
94.0	U	5d5	110.0	Rb	3d	132.0	Po	5p1	149.9	Tb	3O7	168.5	S	Na2SO4	190.9	Yb	4d3	226.1	Ta	4d5	255.1	Se	Auger
94.6	Tl	5p1	110.5	Ni	3s	132.7	Ga	loss	150.5	Si	2s	168.5	S	Na2S2O3	194.0	B	2O3	228.0	Mo	3d5	255.6	W	4d3
95.2	Ir	5s	110.6	Mg	loss	133.4	Al	loss	152.0	Zn	loss	168.6	P	loss	195.0	At	5s	228.0	Nd	4p3	257.0	Tc	3d3
96.0	Br	loss	111.2	Rb	3d3	133.6	Si	loss	152.3	Dy	4d5	168.8	Y	loss	195.0	U	5p3	229.0	S	2s	260.0	Re	4d5
97.0	Ag	4s	111.8	Be	1s	133.7	Sr	3d5	152.9	Sb	4s	169.1	Te	4s	196.0	Lu	4d5	229.4	Mo	O2 (?)	260.0	U	5p1
98.7	Er	Auger	112.6	Te	4p	133.7	Sr	CO3	153.0	Ra	5p3	169.3	Er	4d3	196.1	Zr	loss	229.5	Mo	3d	261.0	As	Auger
99.8	Si	2p3	113.6	Be	O	134.0	Sr	3d	155.8	Y	3d5	173.0	Ba	4p	197.0	La	4p3	229.7	Mo	S2	261.5	Tb	Auger
99.8	Mg	loss	114.7	Be	Ntv Ox	134.9	Sm	2O3	156.1	Dy	2O3	173.3	Ga	loss	197.5	Ge	Auger	229.9	Se	3s	264.3	Rb	loss
99.9	Hg	4f7	115.0	At	5p3	135.5	Sr	3d3	156.6	Y	2O3	175.4	Tm	4d	198.4	Se	Auger	230.0	As	Auger	267.5	S	loss
100.1	Si	2p	115.0	Pr	4d	135.6	Eu	2O3	157.0	Bi	4f7	175.9	Tb	loss	198.7	Cl	2p	231.1	Mo	3d3	267.7	W	loss
100.2	Si	O	115.5	Se	Auger	136.8	Pb	O2	157.0	Bi	4f	176.3	Tm	2O3	198.9	Cl	2p3	232.6	Mo	Ntv Ox	268.0	Fr	4f
100.4	Si	2p1	116.2	Si	loss	136.8	Rb	loss	157.0	Bi	loss	177.0	Po	5s	198.9	Cl	MCl	232.9	Tb	Auger	268.4	Sr	3p3
100.4	Si	C	117.7	Tl	4f7	136.9	Pb	4f7	157.0	Y	3d	177.0	Th	5p3	199.8	Cl	C-Cl	233.0	Kr	3p1	270.0	Cl	2s
100.6	Sb	4p	117.9	Al	2s	137.0	Tl	5s	157.9	Y	3d3	178.7	Se	Auger	200.0	Ra	5p1	233.1	Mo	O3	271.3	Gd	4p3
100.7	Hg	O	118.0	Nd	4d	137.1	Sn	4s	158.5	Cs	4p3	178.7	Zr	3d5	200.5	Cl	2p1	234.0	Fr	5s	273.5	Re	4d3
100.9	Co	3s	118.2	Bi	5p1	137.5	Pb	O	158.8	Bi	2O3	179.9	Zr	3d	201.4	Nb	3d	234.0	Pr	4p1	274.5	Er	Auger
100.9	Hg	S	118.2	Tl	2O3	137.6	Pb	3O4	158.9	Ga	3s	180.9	Cs	4p1	202.3	Nb	3d5	234.0	Th	5p1	275.0	La	4s

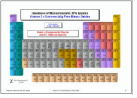
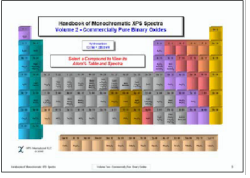


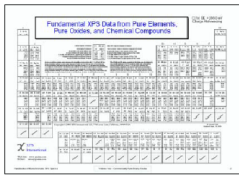
Table 4 (cont.) BE Lookup Table for Signals from Elements and Common Chemical Species

278.7	Sr	3p1	301.6	Mg	Auger	340.3	Pd	3d3	382.0	U	4f	412.7	Lu	4p1	460.2	Gd	Auger	515.0	Eu	Auger	560.0	Pd	3p1
279.0	Os	4d5	305.0	Pr	4s	341.4	Ge	Auger	384.9	Tl	4d5	420.4	Ta	loss	462.5	Ta	4p1	515.6	V	2p	560.9	Ti	2s
280.1	Ru	3d5	305.5	K	loss	342.0	Th	4f5	386.0	Tm	4p1	421.6	Mo	loss	463.1	In	loss	515.9	V	2O3	562.8	Ta	4s
281.0	Ru	Ntv Ox	307.2	Rh	3d5	343.0	Ho	4p1	388.0	U	4f5	423.3	W	4p3	464.0	Bi	4d3	517.1	V	2O5	565.0	Na	Auger
281.1	Ru	O2	308.5	Rh	Ntv Ox	343.0	Zr	3p1	388.3	Se	Auger	424.5	N	loss	466.1	Ru	3p3	517.3	V	O2	567.0	Rn	4d3
282.2	Ru	3d	308.9	Rh	2O3	346.5	Pd	loss	389.8	K	loss	425.0	As	Auger	466.8	Nb	3s	518.5	Re	4p1	568.1	Cu	Auger
282.6	C	VC	308.9	Sr	loss	346.6	Ca	2p	390.3	Yb	4p1	425.0	Tc	3p3	468.0	As	Auger	519.0	As	Auger	570.9	Ga	Auger
282.9	C	NbC	309.4	Rh	3d	347.1	Ca	O	391.7	Ga	Auger	425.5	Pb	loss	468.5	Tm	4s	519.6	Pt	4p3	572.5	Te	CdTe
283.0	C	TaC	310.4	Ge	Auger	347.2	Mg	Auger	391.7	Mg	Auger	429.6	Zr	3s	471.0	Os	4p3	519.7	V	2p1	572.9	Te	3d5
283.0	Sm	4p1	311.0	Tb	4p1	347.8	Ca	UHV Ox	393.8	Mo	3p3	433.0	Ge	Auger	471.5	Zn	Auger	521.3	Rh	3p1	573.0	Zn	Auger
284.0	Tb	Auger	311.1	Y	3p1	349.0	Sm	4s	393.8	Y	3s	434.3	Pb	4d3	473.0	Po	4d5	524.0	Na	Auger	573.6	Ag	3p3
284.2	Ru	3d3	311.9	Ir	4d3	353.0	Au	4d3	395.6	Tb	4s	436.0	Ho	4s	474.0	Se	Auger	524.8	Ge	Auger	574.1	Cr	B
284.5	C	HOPG	311.9	Rh	3d3	357.2	Sr	3s	397.0	N	CrN	437.3	Hf	4p1	474.7	In	loss	528.2	Sb	3d5	574.3	Cr	2p3
284.5	Se	Auger	312.5	Mg	Auger	357.9	Ge	Auger	397.1	N	AlN	437.8	Ca	2s	480.8	Yb	4s	529.4	O	Ag2O, NiO	575.0	Cr	2p
285.0	C	1s	313.0	C	loss	357.9	Mg	Auger	397.3	N	TiN	440.0	Bi	4d5	484.9	Sn	3d5	529.6	Sb	2O3	575.5	Cr	Ntv Ox
285.4	C	C-OR	314.5	Pt	4d5	358.3	Hg	4d5	397.6	N	Si3N4	443.6	Ge	Auger	486.3	Sn	O	529.8	O	MgO	575.6	Cr	2O3
286.0	Cl	loss	315.1	Se	Auger	358.6	Se	Auger	398.4	N	1s	443.8	In	3d5	486.4	Ga	Auger	530.5	O	NaOH	576.5	Te	O2
286.0	Tb	4p3	315.2	Ho	4p3	359.0	As	Auger	398.4	N	BN	444.3	In	2O3	487.3	Sn	O2	531.1	O	Al2O3	576.6	Cr	Ntv Ox
287.0	C	C-Cl	319.5	Ar	2s	359.2	Lu	4p3	398.4	Sc	2p3	444.4	In	Ntv Ox	488.4	Ru	3p1	531.1	Sb	2O5	577.0	Fr	4d5
287.8	C	C=O, C-F	320.0	Nd	4s	359.3	Zr	loss	399.8	Se	Auger	444.8	In	P fract	488.8	Ho	Auger	531.8	O	1s LiOH	577.0	Te	3d
288.9	C	COOR	320.8	Er	4p3	360.8	Nb	3p3	399.9	Tm	Auger	444.9	In	GaAs	490.5	W	4p1	532.3	Pd	3p3	577.2	Hg	4p3
289.0	Eu	4p1	321.2	K	loss	363.0	Eu	4s	400.6	Ta	4p3	445.0	Tc	3p1	493.3	Sn	3d3	532.5	Ga	Auger	577.7	Cr	Ntv Ox
289.0	Kr	3s	321.8	Rb	3s	363.6	Ga	Auger	401.0	Sc	2p	445.2	In	Ntv OH	494.6	Zn	Auger	532.5	O	B2O3, SiO2	578.2	Ir	4p1
289.4	C	MCO3	322.0	U	5s	363.7	Dy	Auger	401.9	Sc	2O3	445.9	In	Ntv CO3	494.8	Ir	4p3	532.6	Sb	3d	579.5	Cr	O3
290.0	Ce	4s	323.6	Mg	Auger	366.0	Er	4p1	402.2	N	H4	446.4	Re	4p3	496.3	Rh	3p3	532.9	O	HgO	579.8	Ge	Auger
290.6	Gd	4p1	326.8	Ge	Auger	366.8	Ag	2S	403.2	Sc	2p1	446.9	Pb	loss	497.1	Se	Auger	533.0	At	4d3	580.0	Cr	KCrO4
290.8	C	C-CO3, CF2	329.4	Zr	3p3	367.7	Ag	O	404.1	Cd	O	447.3	Ga	Auger	497.2	Sn	3d	533.8	Hf	4s	581.8	Zn	Auger
291.7	C	pi->pi*	331.0	Pm	4s	368.2	Ag	Ag, Ag2O	405.0	Cd	3d5	448.0	In	3d	497.4	Na	Auger	536.4	Na	Auger	583.3	Te	3d3
292.7	C	CF3	331.2	Pt	4d3	368.5	Mg	Auger	405.1	Cd	Te	450.3	Er	4s	498.0	Sc	2s	537.6	Sb	3d3	583.5	Cr	2p1
292.9	K	2p3 KX	332.0	Dy	4p1	370.0	Eu	Auger	405.4	Cd	Se, CO3	451.4	In	3d3	499.0	Sn	loss	541.0	Rn	4d5	586.2	Er	Auger
293.0	Os	4d3	332.3	Tm	4p3	371.0	Ag	3d	405.5	Tl	4d3	453.0	Se	Auger	500.0	Po	4d3	544.0	Tc	3s	586.9	Tm	Auger
294.0	Th	5s	333.0	Th	4f7	371.0	As	Auger	406.7	Cd	(OH)2	453.9	Ti	2p3	503.8	Ga	Auger	544.2	Sb	loss	588.9	Ga	Auger
295.0	K	2p	333.1	Mg	Auger	374.2	Ag	3d3	407.2	N	O3	454.3	Na	Auger	505.0	Mo	3s	546.3	Au	4p3	591.0	Ru	3s
295.6	Dy	4p3	334.0	Au	4d5	376.0	Gd	4s	408.0	Cd	3d	455.1	Ti	O	507.0	At	4d5	548.0	Os	4p1	593.6	W	4s
295.7	K	2p1	335.0	Pd	3d5	376.2	Nb	3p1	411.0	Tb	Auger	456.0	Ti	2p	507.5	Sn	loss	548.1	Cu	Auger	600.0	Gd	Auger
296.2	Ir	4d5	335.4	Pd	Ntv Ox	377.2	K	2s	411.3	Mo	3p1	457.4	Ti	2O3	507.9	Lu	4s	552.4	Na	Auger	600.7	Te	loss
296.2	Se	Auger	337.0	Pd	O	377.3	U	4f7	411.7	Cd	3d3	458.0	As	Auger	512.1	V	2p3	553.2	O	loss	603.0	Fr	4d3
299.0	Ra	4f	337.5	Pd	3d	377.8	Hg	4d3	412.0	Pb	4d5	458.2	Ti	CaTiO3	513.2	Na	Auger	553.3	Sb	loss	603.0	Ra	4d5
299.2	Y	3p3	339.0	As	Auger	379.5	Hf	4p3	412.3	Ge	Auger	458.7	Ti	O2	513.5	Ga	Auger	557.1	Tb	Auger	604.0	Ag	3p1
300.6	Sr	loss	339.8	Yb	4p3	381.0	Mg	Auger	412.6	Dy	4s	460.0	Ti	2p1	513.9	Dy	Auger	558.5	Zn	Auger	609.1	Pt	4p1

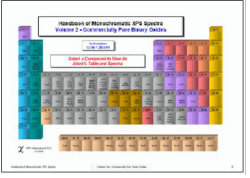
Table 4 (cont.) BE Lookup Table for Signals from Elements and Common Chemical Species

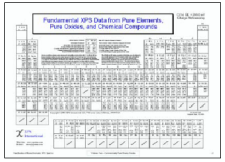
609.6	Tl	4p3	675.0	Xe	3d	724.0	Pt	4s	819.7	Te	3p3	915.9	Cr	Auger	999.0	O	Auger	1107.0	N	Auger	1243.8	Pd	Auger
617.0	Cd	3p3	676.0	Th	4d5	724.8	Cs	3d5	826.0	In	3s	918.6	Cs	Auger	1003.0	Nd	3d3	1108.0	Sm	3d3	1245.9	Tl	Auger
619.0	I	3d	676.7	In	loss	724.8	Cs	Cl	830.5	Co	Auger	925.3	Co	2s	1003.6	Cr	Auger	1109.8	Cd	Auger	1249.0	Ge	2p1
619.2	I	3d5	677.9	Tm	Auger	724.9	Cs	2O:SiO2	833.0	Ce	Auger	929.0	Rn	4p1	1004.8	Te	3s	1112.9	Sb	Auger	1250.8	Pt	Auger
619.2	I	KI	679.0	Bi	4p3	736.0	U	4d5	833.0	F	Auger	930.9	I	3p1	1008.7	Ni	2s	1116.6	Ga	2p3	1259.8	Ru	a
623.2	Ni	Auger	680.2	Hg	4p1	740.0	At	4p3	835.2	La	2O3	931.7	Cu	Cl	1013.0	O	Auger	1117.7	Sc	Auger	1264.2	Mo	Auger
625.2	Re	4s	682.0	Sm	Auger	740.0	Cs	3d3	836.0	La	3d5	931.8	Pr	3d5	1014.7	V	Auger	1126.0	Eu	3d5	1265.0	Rh	Auger
626.1	Ho	Auger	682.4	Xe	3d3	748.0	Ho	Auger	836.5	Te	loss	932.0	Cs	Auger	1020.3	Te	Auger	1128.0	La	3p3	1265.8	Ge	loss
626.4	V	2s	685.1	F	CaF2	749.0	Cs	loss	837.2	La	B6	932.3	Cu	S	1021.7	Zn	O	1128.9	Ag	Auger	1272.0	Ce	3p1
627.8	Rh	3s	685.7	F	1s	756.2	Sn	3p1	837.9	Co	Auger	932.4	Cu	2O	1021.8	Zn	2p3	1129.0	Sn	Auger	1272.0	U	4p1
628.2	Cu	Auger	685.7	F	LiF	758.0	Nd	Auger	841.1	Gd	Auger	932.6	Cu	2p3	1022.3	Zn	S	1131.8	Te	Auger	1275.7	Tb	3d3
629.4	Ga	Auger	688.9	F	CF2	761.1	Pb	4p1	844.2	Cs	Auger	932.9	Cu	2O	1022.5	Sb	Auger	1135.0	Ag	Auger	1296.2	Dy	3d5
630.6	I	3d3	690.9	Ir	4s	761.2	Au	4s	846.0	Fe	Auger	933.9	Cu	O	1027.0	Pm	3d5	1137.0	Ba	3p1	1298.6	Mo	Auger
634.5	Er	Auger	695.7	Cr	2s	761.8	Cs	loss	846.7	Tl	4s	934.0	Xe	3p3	1027.2	Cr	Auger	1141.0	Xe	3s	1303.3	Mg	1s
635.0	Cu	Auger	697.4	Co	Auger	763.4	Gd	Auger	851.0	Po	4p1	934.6	Cu	(OH)2	1031.0	Zn	loss	1143.4	Ga	2p1	1304.0	Cl	Auger
636.0	Ra	4d3	700.3	Tb	Auger	766.4	Sb	3p3	851.6	Mn	Auger	936.6	Bi	4s	1031.9	Sb	Auger	1148.9	Sc	Auger	1307.0	Hf	Auger
638.7	Mn	2p3	702.0	Ne	Auger	768.0	Rn	4p3	852.6	Ni	2p3	940.7	Cu	CT	1034.9	Ti	Auger	1151.0	In	Auger	1315.3	Mg	loss
640.4	Ni	Auger	703.1	In	3p1	768.6	Mn	2s	852.9	Ni	B	942.2	Cu	CT	1042.0	At	4s	1153.0	Fr	4s	1316.1	Pt	Auger
640.5	Ga	Auger	703.5	F	loss	770.2	Sn	loss	853.0	La	3d3	943.8	Cu	CT	1043.0	U	4p3	1155.0	Eu	3d3	1318.0	Ta	Auger
640.9	Mn	Mn3O4	705.0	Po	4p3	772.8	Cd	3s	853.8	Ni	O	944.0	Sb	3s	1044.8	Zn	2p1	1159.4	Pd	Auger	1319.0	Nb	Auger
641.0	Mn	MnO	705.2	Ni	Auger	777.7	Ni	Auger	854.3	Ni	Ntv Ox	944.1	Mn	Auger	1049.6	Sn	Auger	1170.0	Th	4p1	1321.6	Lu	Auger
641.0	Mn	Mn2O3	706.7	Fe	2p3	778.3	Co	2p3	855.4	Ni	(OH)2	945.5	Sb	Auger	1052.0	Pm	3d3	1184.0	Ce	3p3	1322.3	Re	Auger
641.6	Mn	MnO2	707.2	Fe	S2	779.0	U	4d3	859.0	F	Auger	952.2	Cu	2p1	1055.3	V	Auger	1185.5	Rh	Auger	1323.9	As	2p3
642.4	Au	4p1	707.5	Ga	Auger	779.2	Co	O	863.0	Ne	1s	952.2	Pr	3d3	1055.5	Zn	loss	1186.8	Gd	2O3	1324.5	Mo	Auger
643.5	I	loss	709.8	Fe	O	779.5	Co	3O4	869.9	Ni	2p1	952.5	Cs	Auger	1058.0	Ra	4p1	1186.9	Gd	3d5	1326.3	Mg	loss
643.6	Pb	4p3	710.4	Fe	2O3-g	780.0	Ba	3d5	870.5	Cs	Auger	959.5	Cr	Auger	1058.0	Sn	Auger	1190.0	Ag	Auger	1334.0	Pt	Auger
645.0	Mn	2p	710.5	Fe	3O4	780.0	Ba	CO3, OAc	870.7	Te	3p1	959.9	Te	Auger	1063.0	Ba	3p3	1194.0	Ca	Auger	1335.1	Dy	3d3
647.5	Cu	Auger	710.8	Fe	2O3-a	780.6	Co	(OH)2	875.0	I	3p3	965.0	Th	4p3	1067.7	Ti	Auger	1196.4	Zn	2s	1337.7	Zr	Auger
649.7	Mn	2p1	711.5	Fe	OOH	780.9	Co	Ntv Ox	878.1	F	Auger	969.3	Te	Auger	1071.8	Na	2O-SiO2	1208.0	Ra	4s	1352.9	Ho	3d5
651.0	Cd	3p1	711.6	F	loss	782.2	Sb	loss	879.0	Ra	4p3	970.4	I	Auger	1071.9	Na	OH	1213.0	Pd	Auger	1358.7	Er	3d5
652.2	Zn	Auger	712.2	Ni	Auger	784.0	Fe	Auger	882.0	Ce	O2	976.8	V	Auger	1072.0	I	3s	1217.0	Cs	3s	1359.5	As	2p1
655.0	Eu	Auger	713.0	Co	Auger	793.7	Co	2p1	884.0	Ce	3d5	979.7	O	Auger	1072.0	Na	1s	1217.0	Ge	2p3	1363.6	Yb	Auger
655.7	Ga	Auger	713.0	Th	4d3	795.2	Ba	3d3	885.2	Sn	3s	980.0	Fr	4p1	1072.0	Na	Cl	1217.0	Ru	Auger	1365.5	Mo	Auger
657.2	I	loss	714.1	In	loss	797.0	Pr	Auger	886.0	At	4p1	981.0	Nd	3d5	1076.4	In	Auger	1219.6	Gd	3d3	1367.1	Tm	Auger
658.0	Os	4s	714.6	Sn	3p3	802.0	Ba	loss	886.5	Ba	Auger	981.8	I	Auger	1081.0	Sm	3d5	1221.4	C	Auger	1368.2	Zr	Auger
659.4	Zn	Auger	715.1	Er	Auger	803.6	Hg	4s	888.0	Fe	Auger	994.6	Te	Auger	1084.0	In	Auger	1225.0	Ag	Auger	1373.3	Tb	3p3
665.2	In	3p3	719.5	Cu	Auger	805.0	Bi	4p1	888.4	Te	loss	995.0	Po	4s	1092.5	Te	Auger	1234.7	Rh	Auger	1378.9	Gd	3p3
665.3	Ho	Auger	719.6	Ag	3s	808.9	Tb	Auger	891.7	Pb	4s	995.0	Sb	Auger	1097.0	Rn	4s	1234.8	Ge	loss	1390.9	Pb	Auger
669.7	Xe	3d5	719.9	Fe	2p1	810.0	Fr	4p3	898.0	Ba	Auger	996.0	Xe	3p1	1097.2	Cu	2s	1235.0	K	Auger	1392.6	Zr	Auger
671.5	Pd	3s	721.5	Tl	4p1	812.6	Sb	3p1	900.3	Mn	Auger	997.3	Cr	Auger	1102.8	Ti	Auger	1242.0	Pr	3p3	1393.3	Ho	3d3
						817.0	Ba	loss	902.0	Ce	3d3	998.0	Cs	3p3	1103.1	Cd	Auger	1242.1	Tb	3d5	1395.0	Si	Auger

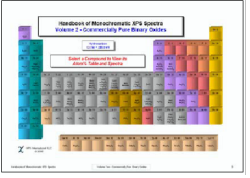


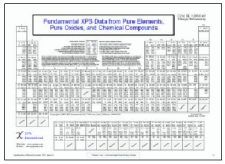


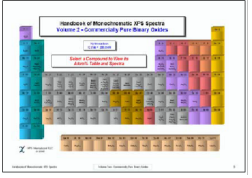
Alphabetical List of XPS Spectra in Volume Two
Binary Oxides, Carbonates and Hydroxides – Alphabetical by Chemical Formula

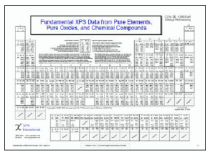


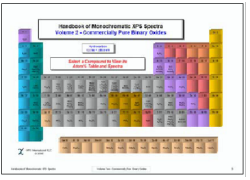


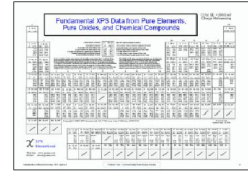












Legend to Spectra Pages

The following pages explain the information presented on the pages of each data set.

P1 =	Table
P2 =	Survey
P3 =	M #1
P4 =	O (1s)
P5 =	C (1s)
P6 =	VB
P7 =	1000 eV
P8 =	M #2
P9 =	X1
P10 =	X2

Information included in each Data Set:

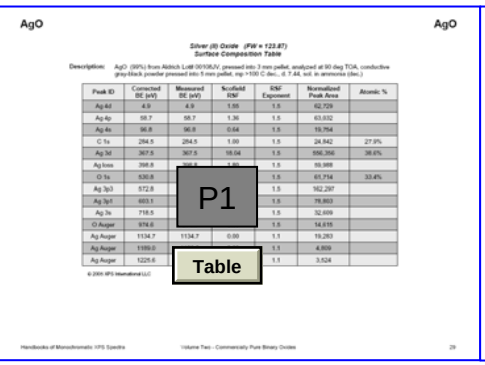
Each “Data Set” includes eight (8) pages shown below as P1-P8. A few data sets contain additional spectra that appear after these eight pages. The name of the XPS signal or energy range contained in each spectrum is printed in boldface lettering just inside the top right corner of each spectrum box. By clicking on the green dashed-line box at the bottom of each page the reader returns to the Periodic Table with links to all the spectra of each compound.

The first page (P1) of each data set has a surface composition table that reports the atom % values of each key element and any unexpected contaminants. This table lists all the peaks that are labeled on the survey spectrum on second page (P2). The description on this page includes: chemical formula, purity, sample preparation and key analysis conditions. The survey scan ranges from 0 to 1,000 eV and is fully labeled. Each spectrum includes an Atom % Composition Summary table that top left corner just inside the spectrum box.

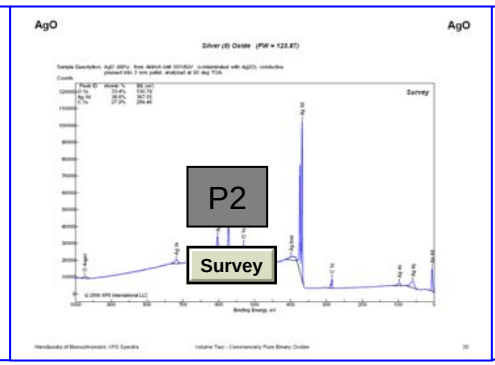
High energy resolution spectra from the key elements (main element, carbon and oxygen) are presented on pages 3-5. All high energy resolution spectra were collected with a 50 eV pass energy, which yields a FWHM = 0.75 eV for freshly ion etched metallic silver (Ag^0). This level of energy resolution readily resolves the presence of different chemical states or species. All binding energies from non-conductive samples are energy referenced so the hydrocarbon C (1s) peak binding energy (BE) appears at 285.0 eV. Each high energy resolution spectrum includes a peak-fit table that includes all of the key peak-fitting results and the conditions used in the peak-fit process.

Each high energy resolution spectrum includes chemical state or chemical species assignments for each peak together with its BE and FWHM values. Those spectra that show spin-orbit coupled pairs (eg $3d_{5/2}$ and $3d_{3/2}$) include a report of the difference in binding energy between the coupled pairs. Multiplet-splitting interactions and shake-up signal that occur for the first row of transition metals are identified on the metal spectra.

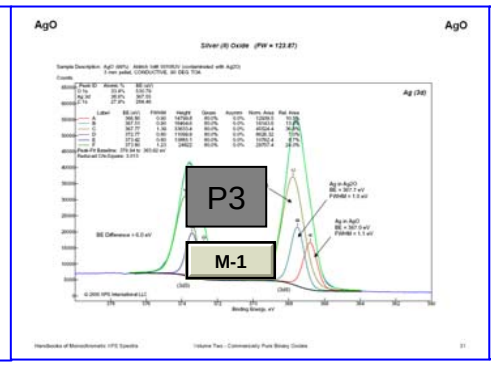
Surface Composition Table



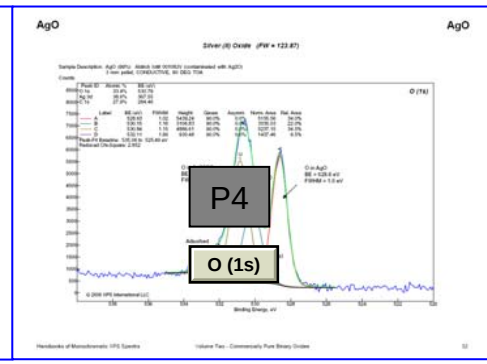
Survey Scan



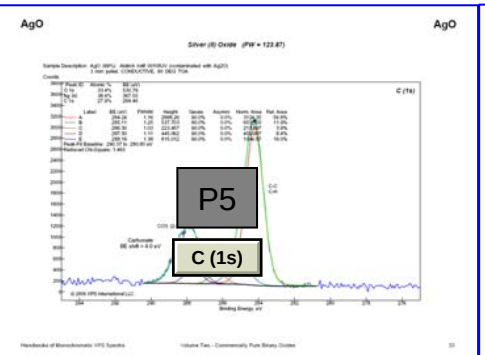
Metal Spectrum #1



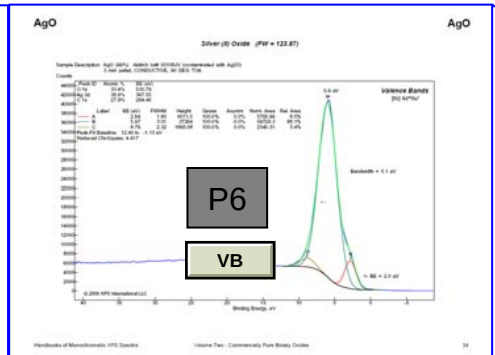
O (1s) Spectrum



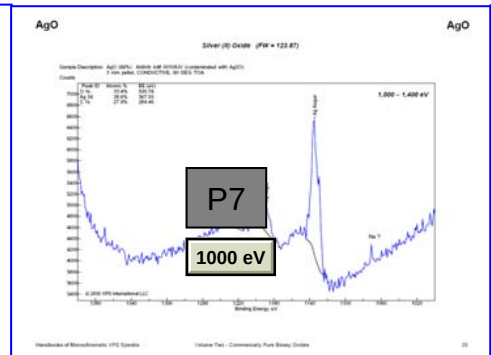
C (1s) Spectrum



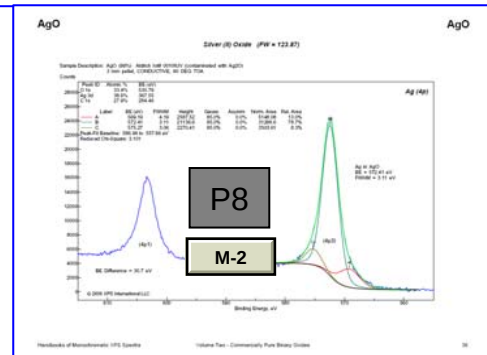
Valence Band Spectrum



1,000-1,400 eV Spectrum



Metal Spectrum #2



P1: Surface Composition Table page

Data sets are alphabetized by chemical formula shown at the top corners of each page.

Surface Composition Table

AgO

AgO

Silver (II) Oxide (FW = 123.87)
Surface Composition Table

Description: AgO (99%) from Aldrich Lot# 00108JV, pressed into 3 mm pellet, analyzed at 90 deg TOA, conductive gray-black powder pressed into 5 mm pellet, mp >100 C dec., d. 7.44, sol. in ammonia (dec.)

Peak ID	Corrected BE (eV)	Measured BE (eV)	Scofield RSF	RSF Exponent	Normalized Peak Area	Atomic %
Ag 4d	4.9	4.9	1.55	1.5	62,729	
Ag 4p	58.7	58.7	1.36	1.5	63,032	
Ag 4s	96.8	96.8	0.64	1.5	19,754	
C 1s	284.5	284.5	1.00	1.5	24,842	27.9%
Ag 3d	367.5	367.5	18.04	1.5	556,356	38.6%
Ag loss	398.8	398.8	1.	1.5	59,988	
O 1s	530.8	530.8	2.	1.5	61,714	33.4%
Ag 3p3	572.8	572.8	8.06	1.5	162,297	
Ag 3p1	603.1	603.1	4	1.5	78,803	
Ag 3s	718.5	718.5	2.93	1.5	32,609	
O Auger	974.6	974.6	0.00	1.5	14,615	
Ag Auger	1134.7	1134.7	0.00	1.1	19,283	
Ag Auger	1189.0	1189.0	0.00	1.1	4,809	
Ag Auger	1225.6	1225.6	0.00	1.1	3,524	

P1 Table

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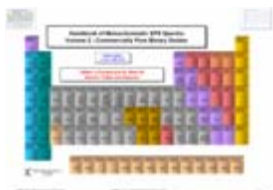
All peaks on each survey scan (P2) are identified (Peak ID) and listed next to their corrected binding energies (BEs).

The atomic percentage (%) of each element is shown here.

The amount of oxygen includes adsorbed water which increases the atom % value beyond the expected theoretical amount.

Use this Link to jump to the Periodic Table of Compounds.



P2: Survey Scan page

Name of XPS signal or energy range

Chemical Formula written in English together with its (oxidation state) and formula weight (FW)

Summary of Atom % with BEs and Peak IDs

Survey Scan

AgO AgO

Silver (II) Oxide (FW = 123.87)

Sample Description: AgO (99%) from Aldrich lot# 00108JV (contaminated with Ag2O), conductive pressed into 3 mm pellet, analyzed at 90 deg TOA

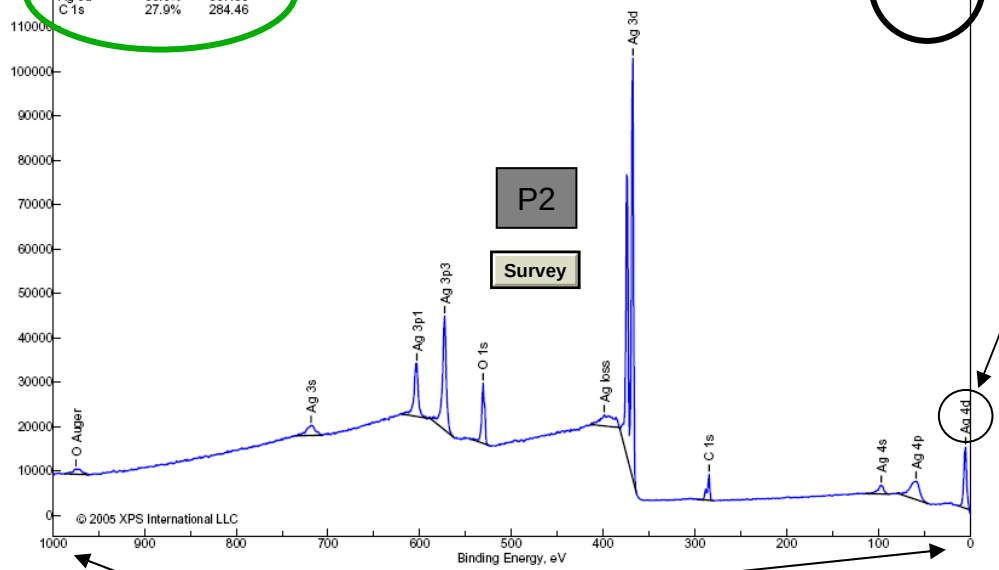
Counts

Peak ID	Atomic %	BE (eV)
O 1s	33.4%	530.79
Ag 3d	38.6%	367.55
C 1s	27.9%	284.46

Survey

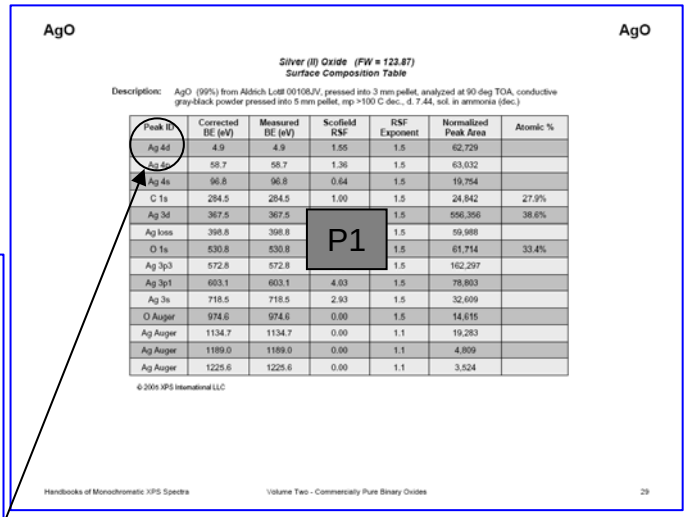
P2

Survey



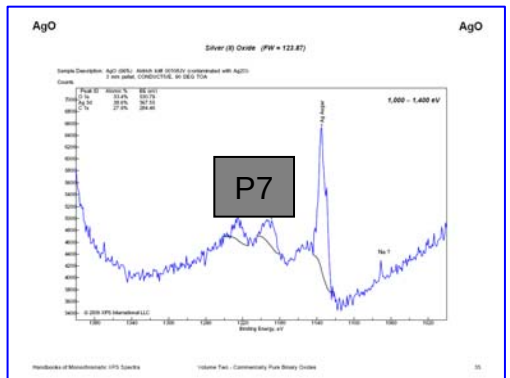
All survey scans run from 0 eV to 1,000 eV.

Surface Composition Table



The higher energy signals in the 1,000 to 1,400 eV range are presented on page seven (P7) of each data set.

1,000-1,400 eV Spectrum



P3: Metal Spectrum #1 page

Name of XPS signal or energy range

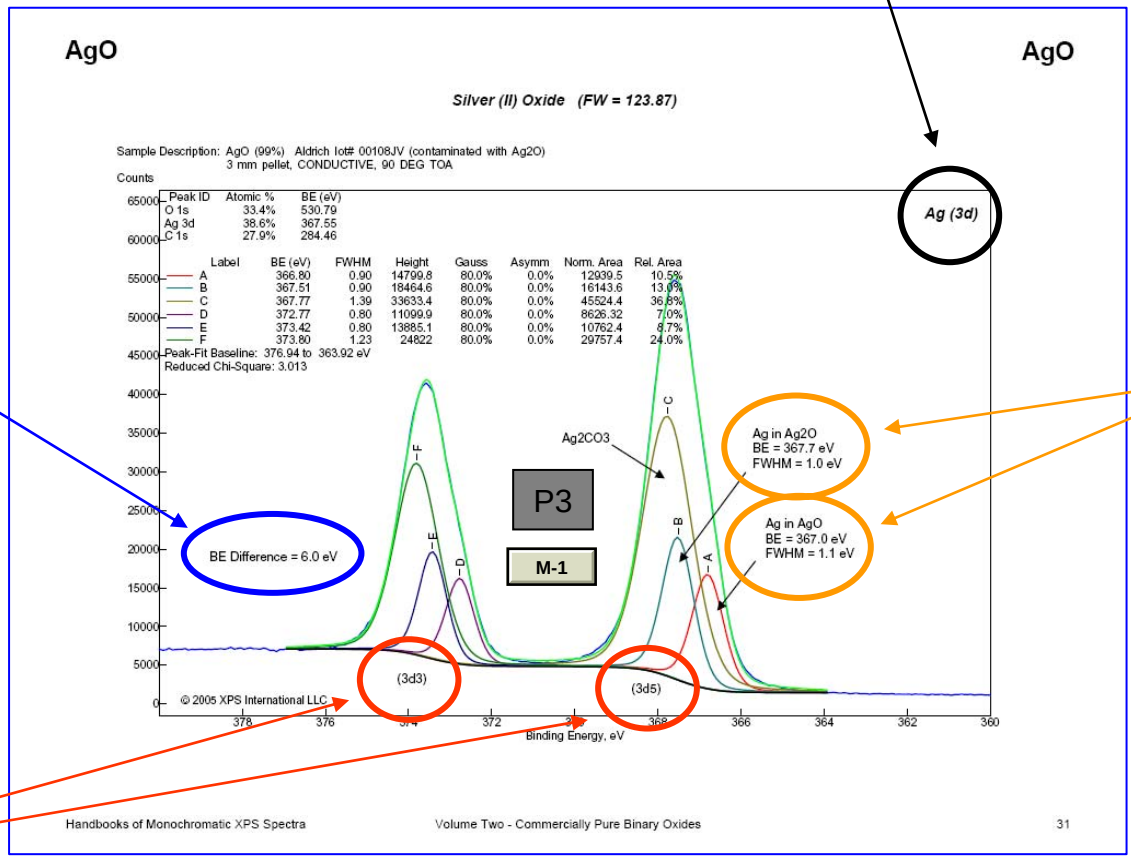
As a direct result of peak-fitting a series of similar compounds we noticed that the FWHM of the metal, O (1s) and C (1s) signals varied between 1.0 and 1.4 eV. This observation was then used to further refine all peak-fits and to decide if the sample suffered from differential charging.

The difference in binding energy between the spin-coupled pairs is listed as “BE Difference”.

The “Chemical State” or “Chemical Species” assignment of a peak is shown just next to the peak itself together with its BE and FWHM.

This spectrum shows the spin-orbit coupled pair from Ag ($3d_{5/2}$) and Ag ($3d_{3/2}$). These labels are abbreviated as (3d5) and (3d3) located just underneath of each peak

Metal Spectrum #1



When spin-orbit coupled pairs are present, the peak-fit results include the theoretical ratio of those two peaks. When the C (1s) and O (1s) spectra indicate the presence of other species, such as carbonate or another chemical state, the peak-fit was adjusted to try to improve the accuracy of the peak-fit results.

P4: O (1s) Spectrum page

As a direct result of peak-fitting a series of similar compounds we noticed that the FWHM of the metal, O (1s) and C (1s) signals varied between 1.0 and 1.4 eV. This observation was then used to further refine all peak-fits and to decide if the sample suffered from differential charging.

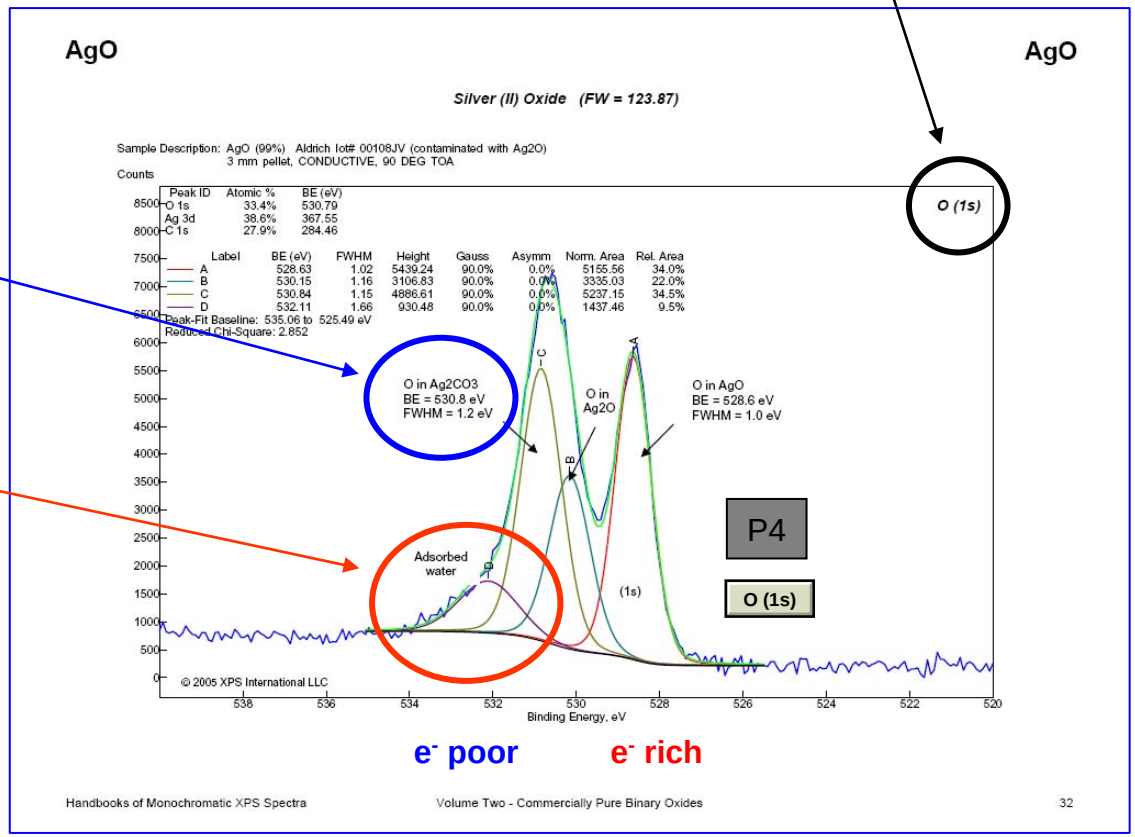
Name of XPS signal or energy range

Some oxides readily form carbonates by reacting with CO_2 in the air.

Adsorbed water is often present on binary oxides.

Rare earth oxides readily collect water from the air, but do not convert to hydroxide form. That is why they are said to be hygroscopic.

O (1s) Spectrum



Higher BE values represent a more electron poor state, a state of lower electron density.

Lower BE values represent a more electron rich state, a state of lower electron density.

When the oxygen atom is highly polarized (electron rich), the O (1s) signal appears between 529-530 eV.

XPS analysis reveals the degree of electron polarization between two adjacent atoms or groups of atoms. As a result it reveals the presence of different chemical states.

P5: C (1s) Spectrum page

Name of XPS signal or energy range

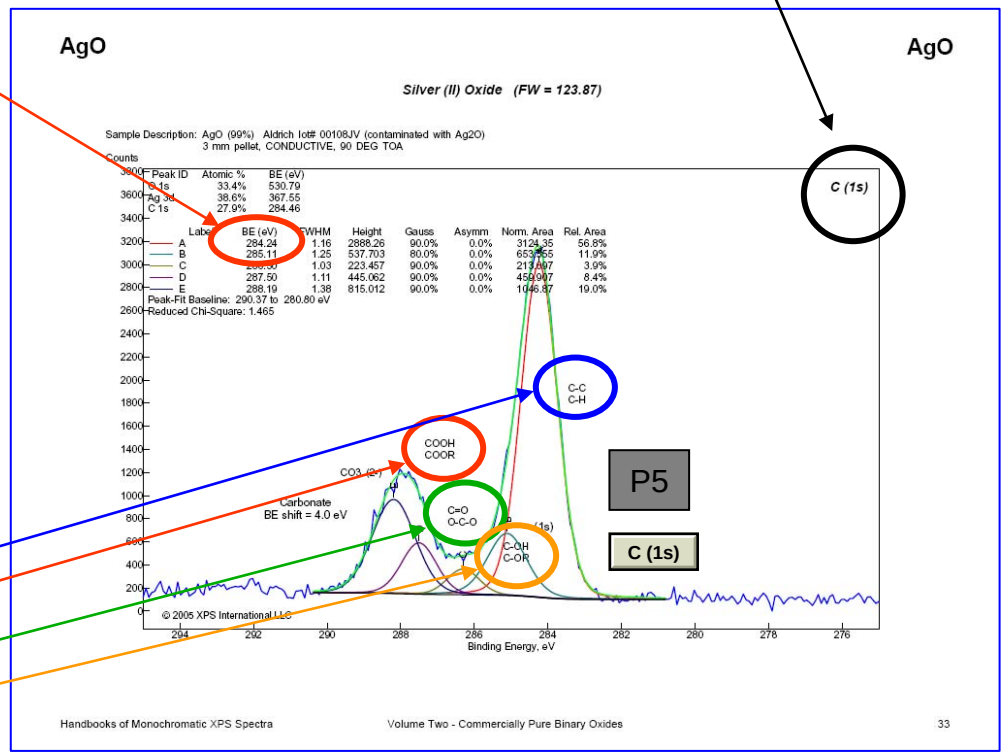
AgO is conductive so the BE of the C (1s) peak is reported exactly as measured.

BEs from all high energy resolution spectra are reported as measured for all samples that are conductive.

Carbon appears on nearly every type of material and is called adventitious carbon. This type of carbon is normally present as four (4) different species:

1. C-C, C-H, (hydrocarbon)
2. O=C-OH, O=C-OC (organic acid, organic ester)
3. C=O, O-C-O, (ketone)
4. C-OH, C-OC, (alcohol)

The "C" label is often replaced by the letter "R" which means that various types of carbon atoms could be present.



Many binary metal oxides are either conductive or semi-conductive so it is not necessary to use a "flood gun" to compensate for the charge-up that occurs on non-conductive samples. In this case, all BEs are reported exactly as measured after peak-fitting. There is no need or valid reason to "charge reference" BEs from any conductive sample or conductive material.

Charge Referencing

During XPS analysis all non-conductive samples experience a shift in energy caused by the loss of electrons. By using a flood of low voltage electrons from a "flood gun" the electric potential of the surface of the sample is normally made to be slightly negative (1-10 eV). This technique provides useful spectra but forces the analyst to correct for the charge induced shift in BEs. The hydrocarbon peak in the C (1s) spectrum is normally the largest peak for adventitious type carbon. This peak is often used as a means of "referencing" the BEs of all the XPS signals from that sample. This is called "Charge Referencing". This book uses a BE of 285.0 eV for the BE of that hydrocarbon peak.

P6: Valence Band Spectrum page

Name of XPS signal or energy range

The Bandwidth value is an energy range value that correlates with the Density of States (DOS) of a material.

This value was measured from the 50% intensity point at the start and finish of the valence bands.

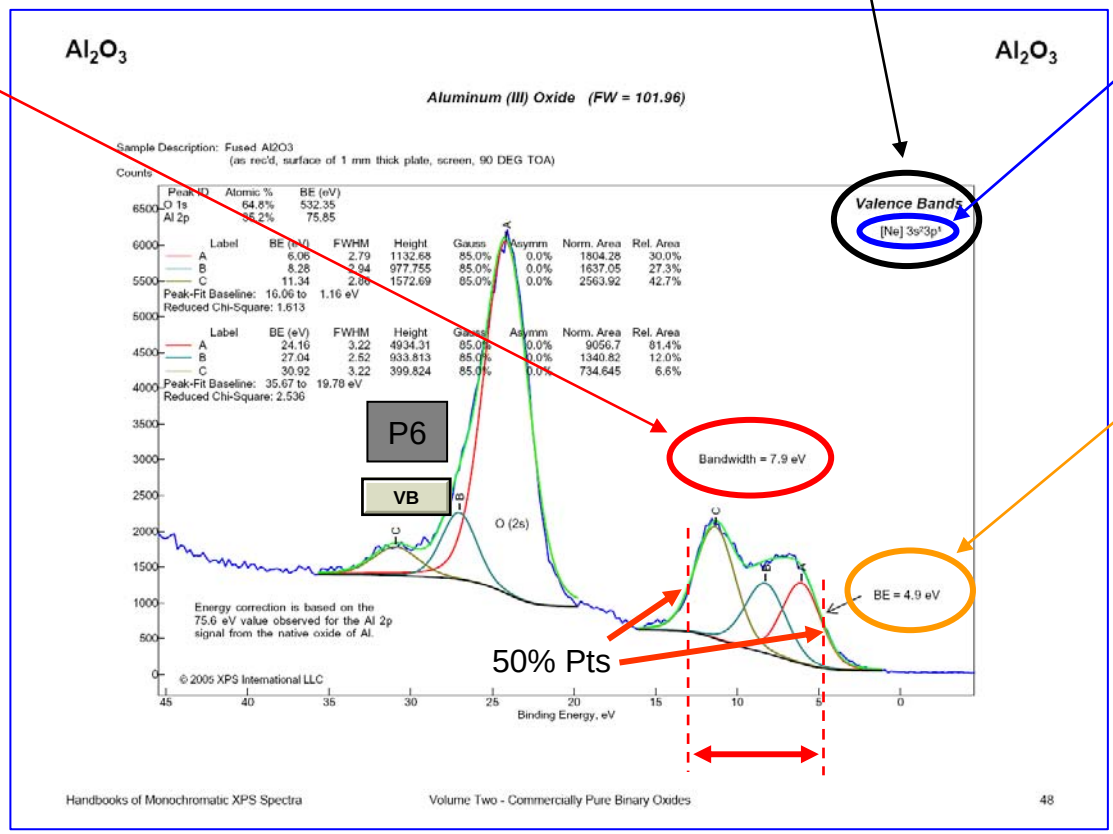
The electron configuration of the pure metal is listed just below the “Valence Bands” title.

This BE value reports the BE for emission onset which is defined to occur at 50% of the lowest BE peak.

For conductive materials this BE can be correlated with the band gap energy and the Fermi edge energy.

The reader should use caution when trying to use this value.

Valence Band Spectrum

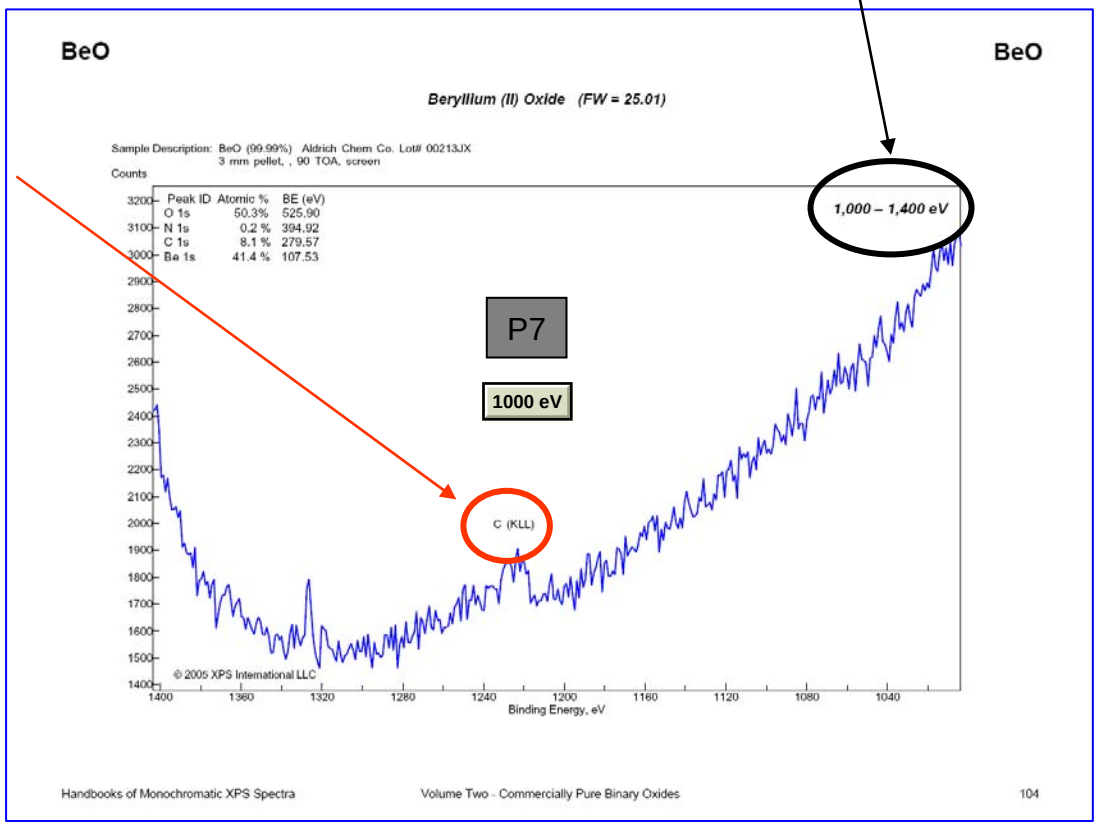


To observe the true shape of the valence bands this spectrum was run from -10 eV to +40 eV.

P7: 1,000 – 1,400 eV Spectrum page

Name of XPS signal or energy range

1,000-1,400 eV Spectrum



The Carbon Auger signal is always present within this region. The C Auger signal appears at 1220 eV in BE which corresponds to 266 eV in KE as found by Auger Electron Spectroscopy.

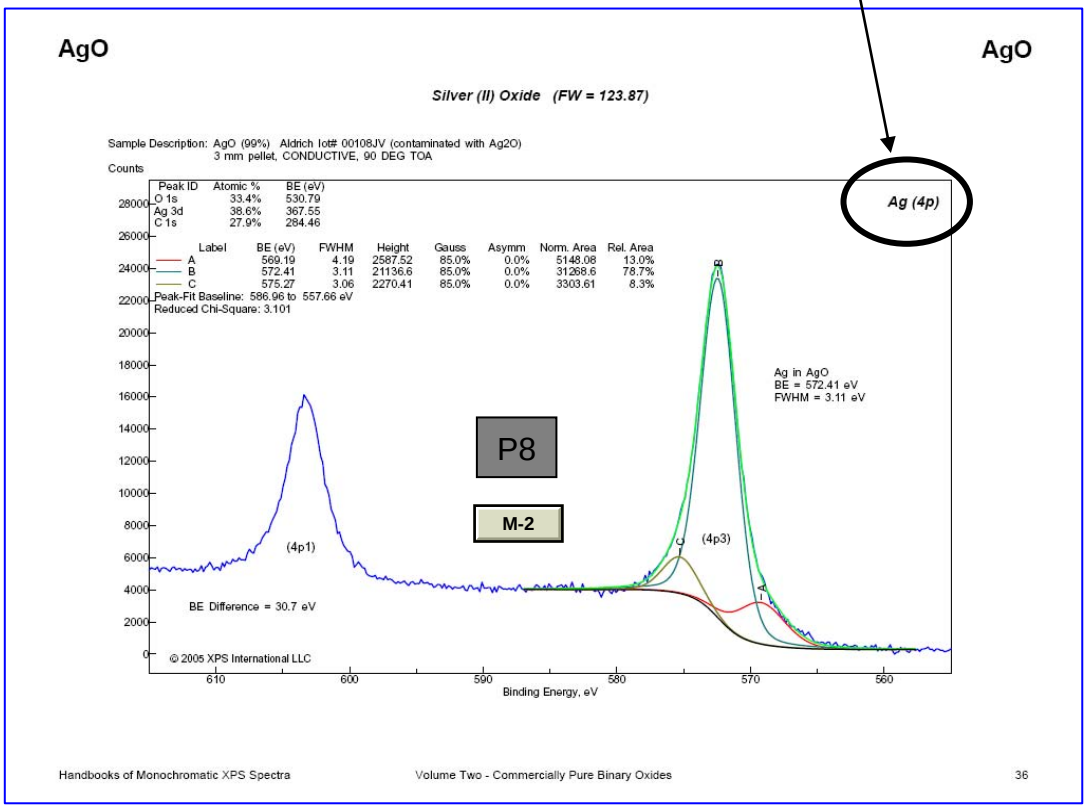
This region includes the Na (1s) peak at 1072 eV which is a common contaminant in various materials.

The binding energy of this spectrum is 1,000 – 1,400 eV. This energy range is seldom analyzed because very few signals appear in this region and because many older instruments do not provide good control of the transmission function in this region which means this region is seldom used to measure atom % values.

P8: Metal Spectrum #2 page

This page contains all the same type of information described on the Legend page of the Metal Spectrum #1 page (P1).

Name of XPS signal or energy range



This page reports data from a secondary signal from the metal within the compound. This data is included because sometimes the main metal spectrum is complicated by the presence of other elements in a real world sample and it may be necessary to use the weaker alternate metal signals to identify the chemistry of the material being analyzed.

A few other spectra may also be included in a data set. There are a few spectra that were measured under ultimate energy resolution conditions. These are identified by the superscript “UR” on the Name of the Signal label in the upper right corner of the spectrum box. There are also a few extended energy range spectra that show Auger bands or plasmon bands.

Handbook of Monochromatic XPS Spectra
Color Table of Commercially Pure Binary Oxides

The Color of the Compound is the Color of the Box XX

Black and Brown-Black Compounds are Conductive
Medium Blue and Medium Green Compounds are Conductive
Dark Red and Red Compounds are Conductive
Pale Red and Pink Compounds are Non-Conductive
All Other Oxides are either White or Transparent

H 1																He 2
H_2O																
Li 3	Be 4										B 5	C 6	N 7	O 8	F 9	Ne 10
Li_2O	BeO										B_2O_3					
Na 11	Fe 26										Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
Na_2O	MgO $Mg(OH)_2$ $MgCO_3$										Al_2O_3 $Al(OH)_3$	SiO SiO_2 $Si(OH)_4$				
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
K_2O	CaO $CaCO_3$	Sc_2O_3	TiO TiO_2 Ti_2O_3	VO_2 V_2O_3 V_2O_5	Cr_2O_3 CrO_3	MnO MnO_2 Mn_2O_3 $MnCO_3$	FeO α-Fe_2O_3 γ-Fe_2O_3 Fe_3O_4 FeOOH	CoO Co_2O_3 Co_3O_4 $Co(OH)_2$	NiO $Ni(OH)_2$	CuO Cu_2O $Cu(OH)_2$	ZnO	Ga_2O_3	GeO_2	As_2O_3			
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
	SrO $SrCO_3$	Y_2O_3 $Y_2(CO_3)_3$	ZrO_2	NbO NbO_2 Nb_2O_5	MoO_2 MoO_3		RuO_2	Rh_2O_3	PdO	AgO Ag_2O	CdO $CdCO_3$	In_2O_3	SnO SnO_2	Sb_2O_3 Sb_2O_5	TeO_2		
Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
Cs_2O	$BaCO_3$	La_2O_3	HfO_2	Ta_2O_5	WO_3	Re_2O_7		IrO_2	PtO_2	Au_2O_3	HgO	Tl_2O_3	PbO PbO_2 Pb_2O_3 $PbCO_3$	Bi2O3 BiOCO3			
Fr 87	Ra 88																

Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71
CeO_2	Pr_6O_{11}			Sm_2O_3	Eu_2O_3	Gd_2O_3	Tb_4O_7	Dy_2O_3	Ho_2O_3	Er_2O_3	Tm_2O_3	Yb_2O_3	Lu_2O_3