Appendices

APPENDIX A

Spectroscopic Notation

The description of "$^{2S+1}$(Molecular term)$_{Subscript}$" symbol (Nassau, 2001)

1. 2S+1 is total spin of valence electron

2. Molecular term symbols (Group theory)

2.1Non – degenerate orbital

- A has a wavefunction symmetric with principle symmetry axis.

- B has a wavefunction antisymmetric with principle symmetry axis.

2.2 Degenerate orbital

- E has a doubly degenerate.

- T has a triply degenerate.

3. Subscript

- 1 is the mirror planes parallel to the symmetric axis.
- 2 is the mirror planes perpendicular to the symmetric axis.
- g is unchanged sign of wavefunction on inversion through a center of symmetry.
- u is unchanged sign of wavefunction on inversion through a center of symmetry.

APPENDIX B

Trajectory Simulation in Al_2O_3

Simulated by SRIM 2008 software

Target Density = 3.9700 g/cm^3 = 1.1724×10^{23} atoms/cm^3

Atom	Atom number	Atomic percent	Mass percent
Al	13	40.00	52.93
O	8	60.00	47.07

Bragg Correction = 0.00%

Table B. The target depth parameters in Al_2O_3.

Ion	Mass (amu)	Ion Energy (keV)	dE/dx Electronic (keV/μm)	dE/dx Nuclear (keV/μm)	Projected Range (Å)	Longitudinal Straggling (Å)	Lateral Straggling (Å)
H^+	1.008	2000	0.1220	7.428×10^{-5}	258600	10500	11800
O^-	15.9995	23	0.6008	0.7324	334	144	105
N_2^+	28.006	50	0.6636	0.6798	785	239	181
N_2^+	28.006	70	0.8443	0.5840	1103	307	244
N_2^+	28.006	80	0.9243	0.5470	1256	337	274
N_2^+	28.006	100	1.045	0.4874	1555	388	329
Ar^+	39.962	50	1.003	2.628	317	102	76
Ar^+	39.932	70	1.187	2.452	435	133	99
Ar^+	39.962	80	1.269	2.370	495	148	110
Ar^+	39.962	100	1.516	2.222	613	176	133

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APPENDIX C

Si(Li) X-ray Detector

The X-ray detector, Canberra, model SSL30150 is used for X-ray detection of PIXE technique. This detector is the acceptor-doped semiconductor type whose is lithium-drifted silicon for the increasing of X-ray energy measurement efficiency. Some parameters are concluded in the Table C.

Table C. The parameters of Si(Li) X-ray detector.

Information of Canberra detector	SSL30150
Be window thickness (cm)	0.0075
Au layer (cm)	1.0E-6
Si crystal thickness (cm)	1.5
Target to crystal distance (cm)	10.4
Ag/At cutoff energy (keV) or if<0, Si dead layer thickness (cm)	-2.2E-5
maximum nominal det res at 5.9 keV	190
default tau (ns)	500
Z values for window, electrode and crystal	4, 79, 14
Pulse dead time in μs	78.
Voigtian line shape switch with cutoff	F 100

APPENDIX D

Converting .SPE File to .PIX File

The PIXE data file is collected in .SPE by MAESTRO software which has the data between channel number in the range of 0 – 1,023 and X-ray count as shown in Figure d-1. This file cannot be directly analyzed by the GUPIXWIN software. The user must erase the heading and footnote which is not related to the data. Moreover, the first line after the heading is also erased and type 1024 instead because the GUPIX software calculate the channel number at 1 to 1024. Then, spacing one times and type zero to clarify the program does not remain the old data. Eventually, the new file arrangement displays as shown in Figure d-2 which is similar to .PIX file and ready to run the spectrum for trace element concentration analysis in GUPIXWIN software.

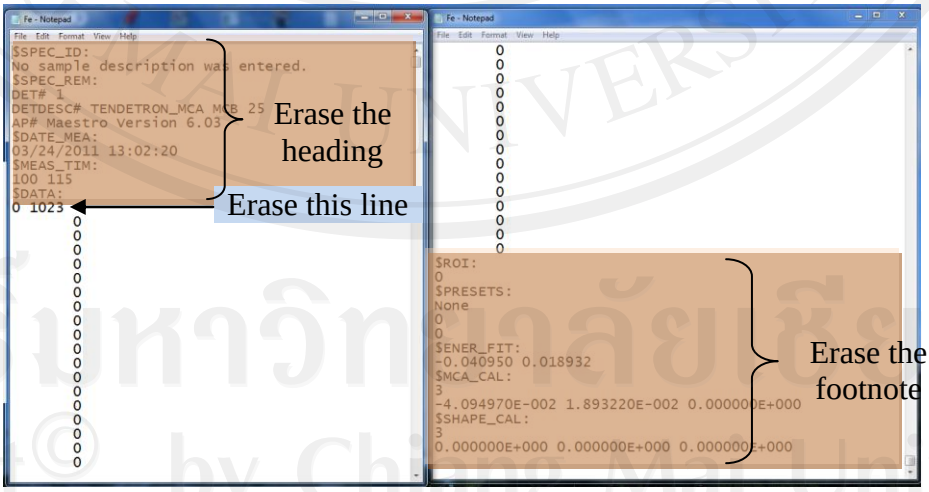

Figure d-1. The .SPE spectrum file.

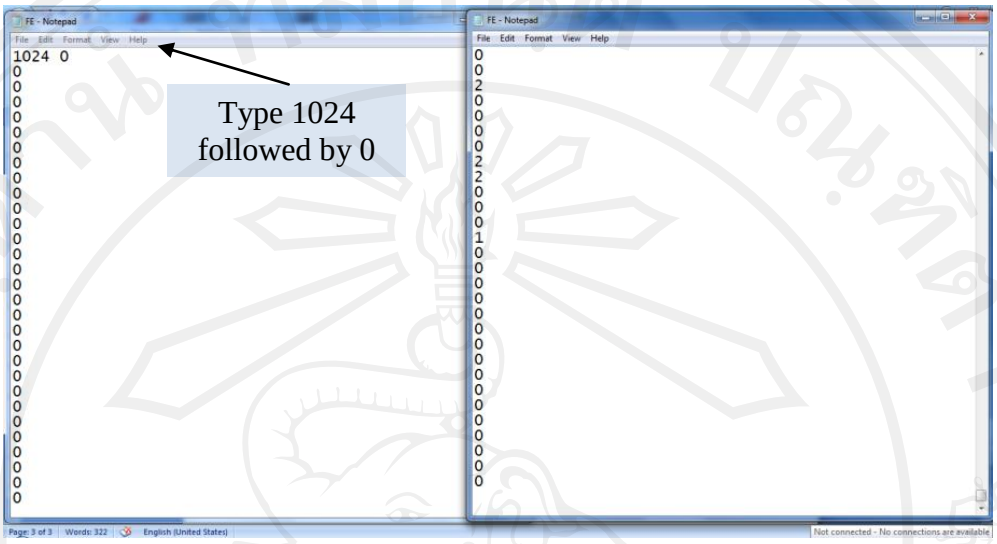

Figure d-2. The .PIX spectrum file.

APPENDIX E

Fiber Optic Light Guide

Table E. The information of the fiber optic light guide.

Factor	Information
Length	1.5 m
Core diameter	1,000 μm
Jacket	Nylon (Temperature range -40^{o}C – 100^{o}C)
Sheathing / Cabling	PVC
Connector	SMA 905
Fiber core	Pure fused silica
Cladding	Doped fused silica
Fiber profile	Step – index multi – mode
Operating wavelengths	UV – VIS (200 – 750 nm)
Numerical aperture	0.22
Recommended minimum bend radius	momentary 20 cm long term 40 cm

APPENDIX F

Ocean Optics S2000 Spectrometer

Table F. The S2000 spectrometer information of Ocean Optics, Inc.

Factor	Information
Size	141.6 mm x 104.9 mm x 40.9 mm
Weight	390 g
Input	110 mA 5 DCV (Master) ; 60 mA 5 DCV (Slave)
Range of measurement	200 – 1,100 nm
Light detector	CCD 2,048 pixels
Grating	14 grating in range of UV – NIR
Income light channel	5, 10, 25, 50, 100 or 200 µm
Focal length	Input 42 mm ; Output 68 mm
Resolving power	0.3 – 10.0 nm (FWHM) (depend upon the grating size)
Loss	<0.05% at 600 nm <0.10% at 435 nm <0.10% at 250 nm
Sensitivity	86 photons/times 2.9 x 10^{-17} J/times 2.9 x 10^{-17} W/times
Connector	SMA 905 single – strand optical fiber (0.22 nA)

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