

# Probe Software

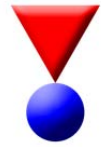
Software for MicroAnalysis

Probe for EPMA

Probe Image

PictureSnapApp

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## CalcZAF: A Free Utility for EPMA

CalcZAF is a small utility application for EPMA that includes calculation of ZAF and Phi-Rho-Z matrix correction parameters from arbitrary compositions with 10 different analytical models to choose from and compare, and 6 different mass absorption coefficient tables for a total of 60 different quantitative options.

CalcZAF (Calculate ZAF and Phi-Rho-Z Corrections) [C:\UserData\CalcZAF\DATA\CALCZAF.DAT]

Fe<sub>3</sub>O<sub>4</sub> (magnetite) from Intensities with Excess Oxygen

STANDARD PARAMETERS:

ELEMENT	STDNUM	STDCONC	STDKFAC	Z-BAR	ABSCOR	FLUCOR	ZEDCOR	ZAFCOR
Si Ka	14	46.740	.4101	10.8047	1.1059	1.0000	1.0306	1.1397
Fe Ka	263	54.809	.5004	18.6926	.9979	1.0000	1.0976	1.0953
Mg Ka	12	60.280	.4736	10.4267	1.2466	1.0000	1.0210	1.2728

ELEMENT	STP-POW	BKS-COR	F(x)e	F(x)s	Eo	Ec	Eo/Ec
Si Ka	1.0565	.9755	.9056	.8189	15.00	1.8390	8.1566
Fe Ka	1.1368	.9655	.9846	.9867	15.00	7.1120	2.1091
Mg Ka	1.0335	.9880	.8665	.6951	15.00	1.3050	11.4943

SAMPLE: 6, ITERATIONS: 3, Z-BAR: 20.96875

ELEMENT	ABSCOR	FLUCOR	ZEDCOR	ZAFCOR	STP-POW	BKS-COR	F(x)u	Ec	Eo/Ec	MACs
Si ka	1.5172	1.0000	.9336	1.4164	.8910	1.0478	.5969	1.8390	8.1566	1955.60
Fe ka	.9969	1.0000	1.0666	1.0633	1.0944	.9746	.9877	7.1120	2.1091	55.6969
Mg ka	2.4698	.9999	.9272	2.2899	.8716	1.0638	.3508	1.3050	11.4943	4477.22

ELEMENT	K-RAN	K-VALUE	ELEMWT%	OXIDWT%	ATOMIC%	FORMULA	KILG/DL
Si ka	-.00008	-.00003	-.005	-.010	-.005	-.001	15.00
Fe ka	1.35236	.67675	71.956	92.571	42.452	7.929	15.00
Mg ka	.00069	.00033	.075	.124	.101	.019	15.00
Mn		.054	.070	.032	.006		
Ca		.000	.000	.000	.000		
Ni		.000	.000	.000	.000		
Al		.201	.380	.245	.046		
O		6.899	6.899	14.207	2.653		
Ti		.012	.020	.008	.002		
O		20.861	----	42.959	8.023		
TOTAL:		100.053	100.053	100.000	18.677		

\* CalcZAF accepts compositions to calculate intensities or calculates composition from intensities using normalized k-ratios, raw k-ratios or unknown and standard counts.

\* CalcZAF calculates binary compositional and empirical intensity datasets for plotting error histograms to evaluate matrix methods.

Calculate Electron and X-ray Ranges

Matrix or Film Composition

Enter Composition as Atom String  
Enter Composition as Weight String  
Enter Composition as Standard

si 21.1990 fe 7.74200 mg 11.6570 ca 10.8990 al 4.90600 mn .077000 o 43.5972 na .043000

Elemental Density of Na equals 0.0009  
Elemental Density of Ca equals 0.971  
Elemental Density of Mg equals 1.738  
Elemental Density of Al equals 2.702  
Elemental Density of Si equals 2.33

Electron Depth Range Radius

Density: 2.7 Electron keV: 15 Calculate Electron Range

Electron range radius = 2.529854 um

$$R_{KO} = \frac{0.0276 A \cdot E_O^{1.67}}{\rho \cdot Z^{0.89}}$$

X-ray Production Depth Range Radius

Element: ka X-Ray: Calculate X-ray Range

X-ray production range radius = 2.520204 um

$$R_{XR} = \frac{0.0276 A \cdot (E_O^{1.67} - E_C^{1.67})}{\rho \cdot Z^{0.89}}$$

X-ray Transmission at 524917 keV

Thickness [um]: Calculate X-ray Transmission

X-ray transmission fraction of thickness 1 um (average u/p = 5902.479) = .2631787

$$\frac{I}{I_0} = e^{-u \cdot \rho \cdot t}$$

X-ray Transmission (at an arbitrary energy)

Energy [keV]: Calculate X-ray Transmission

X-ray transmission fraction at energy 10 keV, thickness of 1 um (average u/p = 37.22671) = .5893551

Electron Energy Loss (for low overvoltage situations)

Uses density, thickness and composition from above fields. Calculate Electron Energy Transmitted

Electron energy transmitted = 14.64209 keV

$$E_{final} = \left( E_O^{1.67} - \frac{\rho \cdot Z^{0.89} \cdot t}{0.276 A} \right)^{1/1.67}$$

\* CalcZAF applies geometric corrections to intensities for particles (cubes, prisms, spheres and fibers) and thin films based on various adjustable parameters.

\* CalcZAF includes Standard, a standard composition utility for "what if" calculations and monte-carlo modeling of electron-solid effects including full GUI support for Penepma 2012 and the newly released fast modeling of secondary fluorescence from boundary phases (see next page).

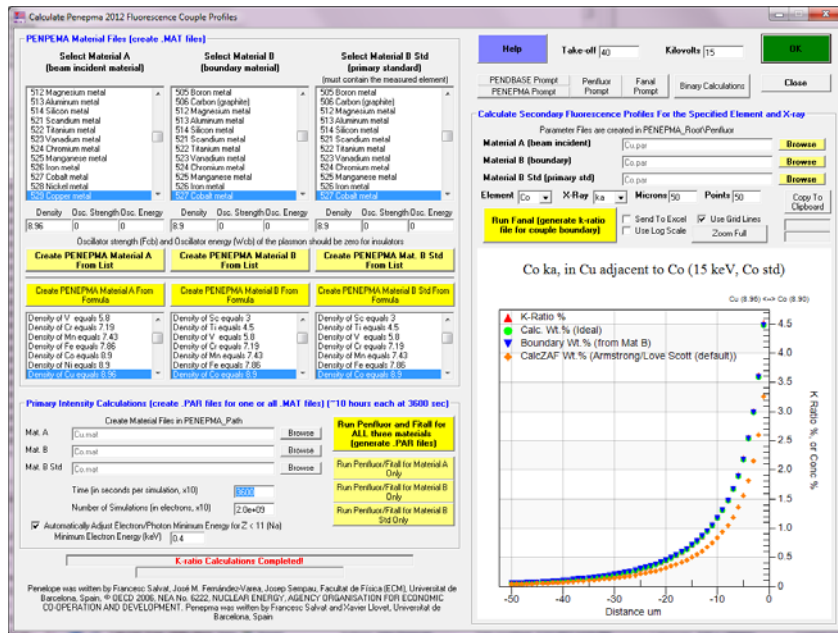
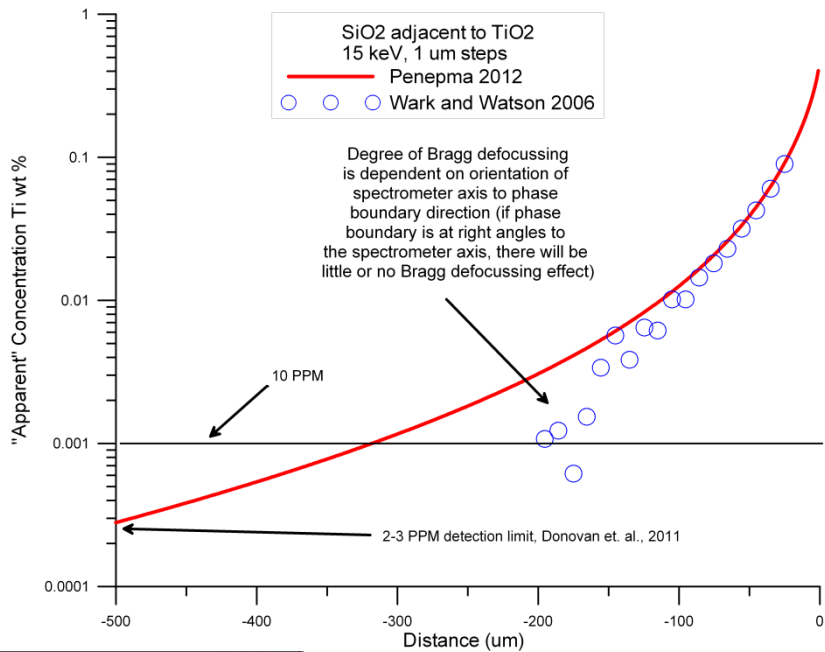
\* CalcZAF has powerful tools for calculating detection limits and x-ray and electron transmission ranges in compounds.

Correction for Secondary Boundary Fluorescence from Nearby Phases

**Probe Software** announces a new feature for the correction of secondary fluorescence boundary effects from nearby phases for WDS and EDS spectrometers.

These boundary fluorescence effects are generally of concern for trace element analysis, but at distances less than tens of microns from phase boundaries, these artifacts can reach the percent level for some element couples, such as Cu-Co, Ni-Fe, Cr-W, etc.

Correction of these boundary fluorescence effects is possible



through recent work by Francesco Salvat and Xavier Llovet at the University of Barcelona, Spain. Use of sophisticated monte-carlo models for electron-photon transport, followed by implementation of these insights into analytical expressions for fluorescence, means that these time consuming and tedious operations can now be performed in a fraction of the time previously required for high precision quantitative calculations.

**Probe Software** is in the process of implementing these newly developed calculations in our **Probe for EPMA** software for automatic

correction of boundary effects in real-time based on the actual distances and analyzed compositions along with corrections for Bragg defocussing and detector orientation effects.

Right now, these quantitative boundary calculations can be modeled off-line using our new Penepma 2012 GUI which can be downloaded for free from Probe Software's technical area along with the previously mentioned CalcZAF and Standard utilities as linked here:

<http://www.probesoftware.com/Technical.htm>

Contact John Donovan for more information.  
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