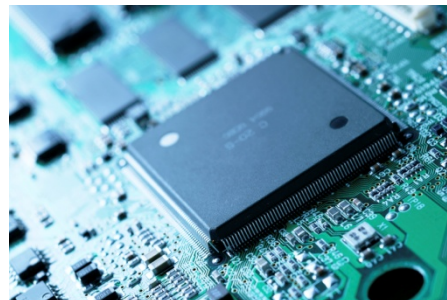


Analysis of Trace Elements in Copper Oxide Using the Prodigy DC Arc Spectrometer

Introduction

Copper(II) oxide, also known as cupric oxide, has a wide range of industrial uses. It is used as a pigment in ceramics to produce blue, red, and green (and sometimes gray, pink, or black) glazes. It can be used to produce other copper salts and is used to produce cuprammonium hydroxide solutions which are used in the production of rayon. It is also occasionally used as a dietary supplement to treat copper deficiency in animals.



Cupric oxide can be used to produce dry cell batteries and has been used in wet cell batteries as the cathode. In this configuration, lithium is typically used as an anode, and dioxalane mixed with lithium perchlorate is used as the electrolyte. In the semiconductor industry, cupric oxide has application as a p-type semiconductor, due to its narrow band gap of 1.2 eV. Cupric oxide is also used when welding copper alloys and can be used as a substitute for iron oxide in thermite. This addition can turn the thermite from an incendiary to a low explosive.

This application note contains data to demonstrate the ability of the Teledyne Leeman Lab's **Prodigy DC Arc** to determine trace elements in high-purity CuO.

Experimental

Operating Parameters

A series of standards was prepared for analysis by using high-purity CuO and a 45 element stock standard obtained from MV Laboratories. Each mixture was thoroughly blended with a SPEX mixer/mill for a minimum of 10 minutes before pressing into pellets. All analyses were performed on the Teledyne Leeman Lab's **Prodigy DC Arc** in atmosphere without the use of the Stallwood Jet. The remaining instrument and method conditions used are listed in [Table I](#).

Table I DC Arc Operating Conditions	
Parameter	Setting
DC Arc Stand	
Current	Ignite at 5.5A, ramp from 5.5A to 6.0A over 20 s; jump to 6.5A, ramp from 6.5A to 7.0A over 20 s
Stallwood Jet	None
Analytical Gap	2 mm for 0-10 s; 3 mm for remaining 30 s
Electrodes	
Counter Electrode	1/8" diameter and pointed (ASTM #C-1)
Sample Electrode	1" long, 1/4" diameter post with a crater (# SP-9012)
Sample	
Sample Size	400 mg pressed pellets
Internal Standard	None
Integration Time	0-40 s for all wavelengths

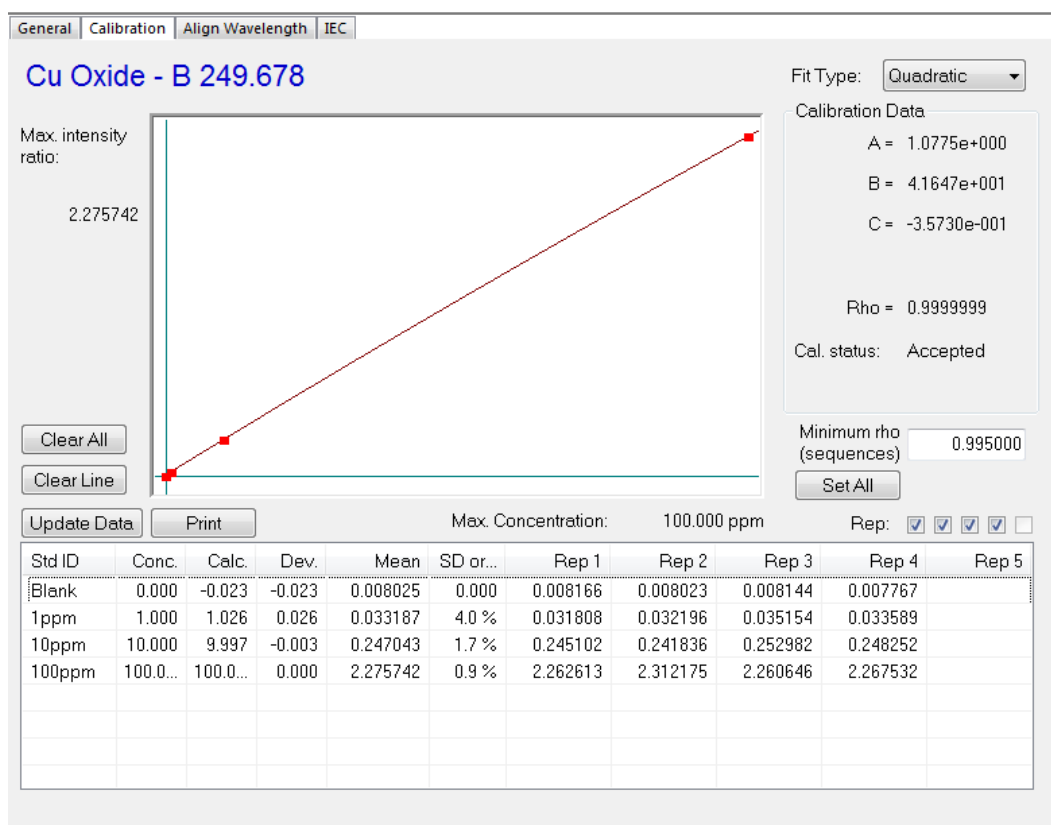
The sample and counter electrodes were purchased from Bay Carbon Inc (Bay City, MI) and used as received. The sample electrodes used were 1" long, 1/4" diameter posts with craters (part # SP-9012). The counter electrodes used for all analyses were 1/8" in diameter and pointed (part # C-1). A 2 mm analytical gap was used for the first 10 seconds of the arc burn and a 3 mm analytical gap was used for the remaining 30 seconds. The position of the electrodes was adjusted during the sample burn to maintain the proper distance between the sample and the counter electrodes.

Calibration

The instrument was calibrated with several high-purity CuO standards that were spiked with a multielement stock standard containing 45 elements at 1.21% each (MV Laboratories, Inc., Frenchtown, NJ). Calibration standards were prepared in this matrix by serial dilution on a weight-to-weight basis such that the analytes of interest were present from 0 to 100 ppm in the CuO matrix. All standards were weighed, mixed and prepared for analysis as described above. Each standard was divided into portions that weighed 400 ± 2 mg each. These portions were individually pressed into 6 mm diameter pellets prior to analysis.

An example calibration curve for elements measured in CuO is illustrated in Figure 1 for B at 249.678 nm. The calibration curve for B demonstrates typical precision and accuracy for the concentrations over which the instrument was calibrated.

Figure 1 Calibration Curve of B at 249.678 nm in High-Purity CuO



Results

Detection Limits

A study was performed to determine the instrument's detection limits for the elements of interest. Detection limits were calculated based on 3 times the standard deviation of 10 replicate measurements of the calibration blank. Results for the detection limit study are listed in [Table II](#) in units of parts per million (ppm).

Table II Detection Limits in High-Purity Copper Oxide							
Element	Wavelength (nm)	Detection Limit (ppm)	Integration Time (s)	Element	Wavelength (nm)	Detection Limit (ppm)	Integration Time (s)
Ag	338.289	0.14	0 – 40	Li	670.784	0.015	0 – 40
Al	396.153	0.54	0 – 40	Mg	279.553	0.37	0 – 40
As	193.759	0.01	0 – 40	Mn	279.827	0.79	0 – 40
B	249.678	0.05	0 – 40	Ni	341.477	0.56	0 – 40
Ba	493.409	0.09	0 – 40	P	255.328	6.59	0 – 40
Be	234.861	0.23	0 – 40	Pb	283.307	0.05	0 – 40
Bi	306.772	0.05	0 – 40	Sb	231.147	0.28	0 – 40
Ca	393.366	0.79	0 – 40	Se	203.985	0.50	0 – 40
Cd	214.438	0.009	0 – 40	Si	250.690	3.32	0 – 40
Co	345.351	0.30	0 – 40	Sn	283.999	0.06	0 – 40
Cr	425.435	0.15	0 – 40	Sr	407.771	1.43	0 – 40
Fe	302.064	1.29	0 – 40	Te	214.275	0.14	0 – 40
Ga	294.364	0.20	0 – 40	V	318.398	0.43	0 – 40
Ge	303.906	0.04	0 – 40	Zn	334.502	0.21	0 – 40
K	766.491	0.009	0 – 40				

Conclusions

The analysis of high-purity copper oxide using the **Prodigy DC Arc** demonstrates that the current-controlled DC Arc power supply, combined with the simultaneous data collection of both peak and background data, provides reproducible sample burns that are reflected in the detection limits obtained for trace elements in a CuO matrix.