Reduction of Matrix-Induced Interferences for Transition Elements Using a Desolvating Nebulizer System with Quadrupole Inductively Coupled Plasma Mass Spectrometry

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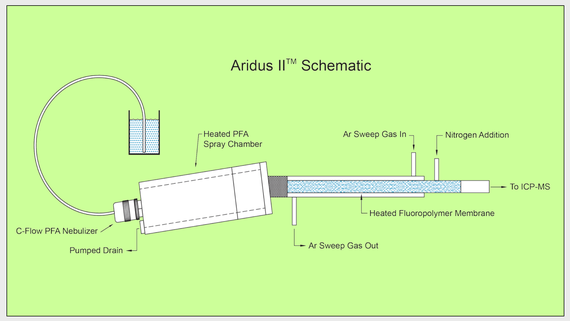
Abstract:

Matrix-based mass spectral interferences can compromise detection of a variety of transition elements when using quadrupole inductively coupled plasma mass spectrometry (ICP-MS). Example interferences include $^{35}Cl^{16}O^{+}$ on $^{51}V^{+}$, $^{40}Ar^{16}O^{+}$ on $^{56}Fe^{+}$, and molybdenum oxides on all cadmium isotopes except ^{106}Cd. Cell-based quadrupole ICP-MS instruments can reduce such interferences using collision and/or reaction gases, but multi-element method development can be complex.

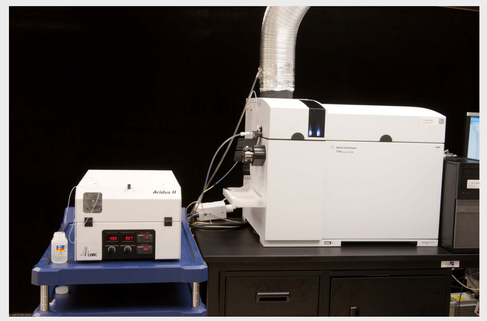
This poster will describe the use of a desolvating nebulizer system with quadrupole ICP-MS for reduction of the above listed interferences without use of cell gases. Installation steps and operating parameters for the desolvating nebulizer system will be detailed and figures of merit will include calibration, background equivalent concentrations (BECs), and instrument detection limits (IDLs).

Teledyne CETAC AridusII Desolvating Nebulizer



Teledyne CETAC AridusII Schematic

AridusII – Front Door Open



Agilent 7700x Q-ICP-MS with AridusII

Selected Mass Spectral Interferences

- $^{35}Cl^{16}O^{+}$ interference on $^{51}V^{+}$ (^{51}V, 99.8%)
- $^{35}Cl^{16}OH$ & $^{40}Ar^{12}C^{+}$ interferences on $^{52}Cr^{+}$ (^{52}Cr, 83.8%)
- $^{37}Cl^{16}O^{+}$ & $^{40}Ar^{12}CH^{+}$ interferences on $^{53}Cr^{+}$ (^{53}Cr, 9.5%)
- $^{40}Ar^{14}N^{+}$ interference on $^{54}Fe^{+}$ (^{54}Fe, 5.8%)
- $^{40}Ar^{16}O^{+}$ interference on $^{56}Fe^{+}$ (^{56}Fe, 91.7%)
- $^{40}Ar^{16}OH^{+}$ interference on $^{57}Fe^{+}$ (^{57}Fe, 2.2%)
- $^{40}Ar^{18}O^{+}$ interference on $^{58}Fe^{+}$ (^{58}Fe, 0.28%)
- $^{92}Mo^{16}O^{+}$ interference on $^{108}Cd^{+}$ (^{108}Cd, 0.89%)
- $^{94}Mo^{16}O^{+}$ interference on $^{110}Cd^{+}$ (^{110}Cd, 12.5%)
- $^{95}Mo^{16}O^{+}$ interference on $^{111}Cd^{+}$ (^{111}Cd, 12.8%)
- $^{96}Mo^{16}O^{+}$ interference on $^{112}Cd^{+}$ (^{112}Cd, 24.1%)
- $^{97}Mo^{16}O^{+}$ interference on $^{113}Cd^{+}$ (^{113}Cd, 12.2%)
- $^{98}Mo^{16}O^{+}$ interference on $^{114}Cd^{+}$ (^{114}Cd, 28.7%)
- $^{100}Mo^{16}O^{+}$ interference on $^{116}Cd^{+}$ (^{116}Cd, 7.5%) % abundance in ( ).

Quadrupole ICP-MS Parameters

Q-ICP-MS:	Agilent 7700x
ICP RF Power:	1550 W
Sample Depth:	9.0 mm
Carrier Gas:	1.00 L/min
Nebulizer Pump:	0.1 rps, 0.4 mL/min
Makeup Gas:	0.10 L/min
Cell Gases:	Off
Nebulizer:	MicroMist Glass Concentric
Spray Chamber:	Scott-type, 2 C
Torch Injector:	Quartz, 2.0 mm i.d.
Resolution:	0.7 amu
Points/Peak:	3
Data Acquisition:	0.99 s/mass, 5 replicates

Desolvating Nebulizer Parameters

Nebulizer System:	Teledyne CETAC AridusII
ICP RF Power:	1550 W
Sample Depth:	3.5 mm
Carrier Gas:	0.90 L/min
PFA Nebulizer:	Aspire 100 (retuned)
Uptake Rate:	150 µL/min
Spray Chamber:	PFA, cylindrical
Cell Gases:	Off
Resolution:	0.7 amu
Spray Chamber Temp:	110 C
Membrane Oven Temp:	160 C
Ar Sweep Gas:	4.59 L/min
N_2 Addition Gas:	0 mL/min (off)

ICP-MS Ion Optic Setting Comparison

Ion Optic	Standard Nebulizer	AridusII
Extract 1	2.0 V	-2.0 V
Extract 2	-180.0 V	-210.0 V
Omega Bias	-90 V	-110 V
Omega Lens	12.0 V	12.0 V
Cell Entrance	-50 V	-50 V
Cell Exit	-50 V	-50 V
Deflect	11.0 V	10.0 V
Plate Bias	-50 V	-60 V
OctP Bias	-12.0 V	-11.0 V
OctP RF	190 V	190 V
Energy Discrim.	5.0 V	5.0 V

Experiment Design

1. The ICP-MS (standard configuration) was first tuned for best sensitivity and a %CeO/Ce of 1.12%. Standard solutions containing 0.5, 1.0, 2.0, and 5.0 µg/L V, Cr, and Fe (all in 1% (v/v) high-purity HNO_3) and 1, 2, 5, and 10 µg/L Cd (in 1.0% (v/v) high-purity HNO_3) were then introduced to the ICP-MS using the standard glass concentric nebulizer and spray chamber.

2. Solutions containing 1% (v/v) high-purity HCl, 1% high-purity (v/v) HNO_3, and 1mg/L Mo (in 1% (v/v) high-purity HNO_3) were then introduced to the ICP-MS using the standard nebulizer and spray chamber as samples.

3. Background equivalent concentrations (BECs) were measured from the 1% (v/v) HCl for ^{51}V, ^{52}Cr, and ^{53}Cr; 1% HNO_3 for ^{54}Fe, ^{56}Fe, ^{57}Fe, and ^{58}Fe; and 1 mg/L Mo for ^{108}Cd, ^{110}Cd, ^{111}Cd, ^{112}Cd, ^{113}Cd, ^{114}Cd, ^{116}Cd.

4. The AridusII was connected to the ICP-MS and the combination tuned for best sensitivity (no added N_2) and a %CeO/Ce of 0.019%. The same solution measurements were then repeated using the AridusII.

Interference Signal Reduction

Element	m/z	Std. Neb (cps)	AridusII (cps)	Factor
V	51	570,129	160	3563
Cr	52	98,327	9,934	9.9
Cr	53	201,711	554	374
Fe	54	274,063	157,119	1.7
Fe	56	12,163,067	66,685	182
Fe	57	24,708	739	33.4
Fe	58	34,288	7,678	4.5
Cd	108	34,638	1,951	17.5
Cd	110	23,067	1,319	17.5
Cd	111	40,725	2,249	18.1
Cd	112	44,230	2,887	15.3
Cd	113	26,176	1,443	18.1
Cd	114	66,931	3,931	17.0
Cd	116	31,764	7,578	4.2

BECs Without & With AridusII

Element	m/z	Std. Neb (µg/L)	AridusII (µg/L)	Reduction Factor
V	51	2.31	0.10	23.1
Cr	52	0.42	0.08	5.2
Cr	53	7.53	0.13	57.9
Fe	54	17.9	4.52	3.9
Fe	56	50.0	0.12	416
Fe	57	3.73	0.06	62.1
Fe	58	45.2	4.87	9.3
Cd	108	14.40	0.34	42.3
Cd	110	0.65	0.02	32.5
Cd	111	1.11	0.03	37
Cd	112	0.63	0.02	31.5
Cd	113	0.72	0.02	36
Cd	114	0.78	0.02	39
Cd	116	1.32	0.13	10.1

IDLs and LOQs with AridusII

Element	m/z	IDL (µg/L)	LOQ (µg/L)
V	51	0.00009	0.0003
Cr	52	0.0009	0.003
Cr	53	0.002	0.006
Fe	54	0.09	0.31
Fe	56	0.008	0.026
Fe	57	0.010	0.032
Fe	58	1.7	5.6
Cd	108	0.04	0.13
Cd	110	0.002	0.007
Cd	111	0.005	0.015
Cd	112	0.001	0.003
Cd	113	0.002	0.006
Cd	114	0.002	0.006
Cd	116	0.011	0.035

IDLs based on 3x std. dev of the interference background.
LOQs based on 10x std. dev. of the interference background.