

Determination of zinc, cadmium and lead by anodic stripping voltammetry at a mercury film electrode

Summary

This Application Bulletin describes the determination of zinc at a mercury film electrode (MFE). Zinc can also be determined simultaneously with cadmium and lead. The determination of copper at the MFE is not possible. The mercury film is plated *ex-situ* on a glassy carbon electrode and can be used for half a day up to one day.

Zinc can be determined at the mercury film electrode by anodic stripping voltammetry (ASV). The presence of copper, which is naturally present in many samples, affects the determination of zinc due to the formation of an intermetallic compound. As a result the determined concentrations of zinc are too low. The addition of gallium can eliminate the interference to a certain extent since the intermetallic complex of gallium and copper is more stable than the complex of zinc and copper.

With a deposition time of 10 s, the limit of detection is $\beta(\text{Zn}^{2+}) = 0.15 \text{ } \mu\text{g/L}$. The linear working range goes up to approx. 300 $\mu\text{g/L}$. With the deposition time of 10 s the method is suitable for samples between 10 $\mu\text{g/L}$ and 150 $\mu\text{g/L}$ Zn content. For samples with lower concentrations the results are more reliable if the deposition time is increased to e.g. 30 s. Samples with higher concentrations have to be diluted.

Samples

Surface water, ground water, sea water, waste water

Instruments

884 Professional VA	2.884.0210
Accessories	
viva 2.0	6.6065.20x
Electrode equipment with GC-RDE	6.5339.040
Containing (besides the three electrodes):	
Measuring vessel 5 mL	6.1415.150
Electrolyte c(KCl) = 3 mol/L	6.2308.020
Polishing set	6.2802.000

Electrodes

WE	Glassy carbon electrode tip	6.1204.600
	Driving axle for RDE	6.1204.510
RE	Ag/AgCl reference electrode	6.0728.120
	Ag/AgCl/KCl (3 mol/L)	
	Electrolyte vessel	6.1245.010
	Filled with c(KCl) = 3 mol/L	
AE	Glassy carbon rod	6.1247.000
	Electrode holder	6.1241.120

Reagents

- Zn standard stock solution, $\beta(\text{Zn}^{2+}) = 1 \text{ g/L}$
- Hg standard stock solution, $\beta(\text{Hg}^{2+}) = 1 \text{ g/L}$
- Ga standard stock solution, $\beta(\text{Ga}^{3+}) = 1 \text{ g/L}$
- Nitric acid, w(HNO_3) = 65%, for trace analysis*, CAS 7697-37-2
- Hydrochloric acid, w(HCl) = 30%, for trace analysis*, CAS 7647-01-0
- Acetic acid, w(CH_3COOH) = 100%, for trace analysis*, CAS 64-19-7
- Sulfuric acid, w(H_2SO_4) = 96%, for analysis, CAS 7664-93-9
- Ammonium hydroxide solution, w(NH_3) = 25%, for trace analysis*, CAS 1336-21-6
- Potassium chloride, KCl, for trace analysis*, CAS 7447-40-7
- Ultrapure water, resistivity >18 $\text{M}\Omega \cdot \text{cm}$ (25 °C), type I grade (ASTM D1193)

In addition if UV digestion is required:

- Hydrogen peroxide solution, w(H_2O_2) = 30%, for trace analysis*, CAS 7722-84-1

In addition if also Cd and Pb should be determined:

- Cd standard stock solution, $\beta(\text{Cd}^{2+}) = 1 \text{ g/L}$
- Pb standard stock solution, $\beta(\text{Pb}^{2+}) = 1 \text{ g/L}$

* e.g., Merck suprapur®, Honeywell Fluka TraceSelect® or equivalent

Solutions

Hg plating solution	$\beta(\text{Hg}^{2+}) = 20 \text{ mg/L}$ $c(\text{HCl}) = 0.1 \text{ mol/L}$ 0.4 mL Hg standard stock solution and 0.2 mL hydrochloric acid are diluted to 20 mL with ultrapure water.
Electrolyte	$c(\text{CH}_3\text{COOH}) = 2 \text{ mol/L}$ $c(\text{NH}_3) = 1 \text{ mol/L}$ $c(\text{KCl}) = 1.5 \text{ mol/L}$ 55.9 g KCl are dissolved in approx. 300 mL water. 55.5 mL acetic acid and 37 mL ammonium hydroxide solution are added and filled up to 500 mL with ultrapure water.
Ga solution	$\beta(\text{Ga}^{2+}) = 100 \text{ mg/L}$ Approx. 40 mL ultrapure water is filled into a 50 mL volumetric flask. 5 mL Ga standard stock solution are added. The solution is made up to the mark with ultrapure water.

Standard solutions

Zn standard solution 5 mg/L	$\beta(\text{Zn}^{2+}) = 5 \text{ mg/L}$ Approx. 40 mL ultrapure water is filled into a 50 mL volumetric flask. 0.05 mL $w(\text{HNO}_3) = 65\%$ and 0.25 mL Zn standard stock solution are added. The solution is made up to the mark with ultrapure water.
Zn standard solution 1 mg/L	$\beta(\text{Zn}^{2+}) = 1 \text{ mg/L}$ Approx. 40 mL ultrapure water is filled into a 50 mL volumetric flask. 0.05 mL $w(\text{HNO}_3) = 65\%$ and 0.05 mL Zn standard stock solution are added. The solution is made up to the mark with ultrapure water.
Cd standard solution	$\beta(\text{Cd}^{2+}) = 0.5 \text{ mg/L}$ Approx. 40 mL ultrapure water is filled into a 50 mL volumetric flask. 0.05 mL $w(\text{HNO}_3) = 65\%$ and 0.025 mL Cd standard stock solution are added. The solution is made up to the mark with ultrapure water.
Pb standard solution	$\beta(\text{Pb}^{2+}) = 1 \text{ mg/L}$ Approx. 40 mL ultrapure water is filled into a 50 mL volumetric flask. 0.05 mL $w(\text{HNO}_3) = 65\%$ and

0.05 mL Pb standard stock solution are added. The solution is made up to the mark with ultrapure water.

Check standard solutions

Check standard 5 $\mu\text{g/L}$	$\beta(\text{Zn}^{2+}) = 5 \mu\text{g/L}$ The check standard solution is prepared <i>in-situ</i> with 10 mL ultrapure water, 0.5 mL electrolyte, 0.1 mL Ga solution and 0.05 mL Zn standard solution 1 mg/L.
Check standard 10 $\mu\text{g/L}$	$\beta(\text{Zn}^{2+}) = 10 \mu\text{g/L}$ The check standard solution is prepared <i>in-situ</i> with 10 mL ultrapure water, 0.5 mL electrolyte, 0.1 mL Ga solution and 0.1 mL Zn standard solution 1 mg/L.
Check standard 50 $\mu\text{g/L}$	$\beta(\text{Zn}^{2+}) = 50 \mu\text{g/L}$ The check standard solution is prepared <i>in-situ</i> with 10 mL ultrapure water, 0.5 mL electrolyte, 0.1 mL Ga solution and 0.1 mL Zn standard solution 5 mg/L.
Check standard 100 $\mu\text{g/L}$	$\beta(\text{Zn}^{2+}) = 100 \mu\text{g/L}$ The check standard solution is prepared <i>in-situ</i> with 10 mL ultrapure water, 0.5 mL electrolyte, 0.1 mL Ga solution and 0.2 mL Zn standard solution 5 mg/L.

Sample preparation

- Ground water, drinking water, sea water, and mineral water can usually be analyzed directly.
- Water that contains interfering organic substances is digested using the 909 UV Digester:
10 mL acidified water sample ($\text{pH} = 2$) with 20 μL $w(\text{HCl}) = 30\%$ and 100 μL $w(\text{H}_2\text{O}_2) = 30\%$ are irradiated for 90 min at 90 °C.

Comments

- No platinum auxiliary electrode should be used in combination with a glassy carbon working electrode.
- Measuring vessel and reference electrode have to be free of platinum traces. Therefore it is recommended to have accessories dedicated to this application.

Mercury film plating

Preparation of the glassy carbon electrode

The glassy carbon electrode has to be clean and free of any insulating material before the mercury film can be plated. For cleaning the following procedure is recommended.

- With a soft tissue deposit, e.g. an old mercury film, is wiped off the electrode surface.
- For polishing the glassy carbon electrode a small amount of aluminum oxide (5 ... 10 mg) is mixed with a few drops of water (0.2 ... 0.5 mL) on the polishing cloth (part of the polishing set 6.2802.000) to form a slurry. The electrode is then polished with small 8-shaped movements on the polishing cloth.
- The slurry is rinsed off the electrode with ultrapure water.
- The electrode is then rinsed with ethanol and afterwards thoroughly with ultrapure water.

This procedure should be carried out each time before plating the mercury film.

Plating the mercury film

20 mL Hg plating solution are transferred into the measuring vessel. The plating is carried out using the parameters given under «Parameters for mercury film plating» with 2 replications for the plating.

Measuring solution

20 mL Hg plating solution

Parameters for mercury film plating

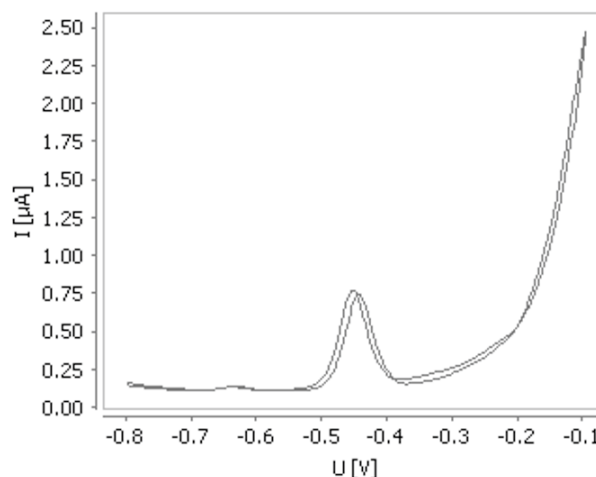
Voltammetric	
Measuring mode	DP – Differential pulse
Stirring rate	2000 min ⁻¹
Cyclic voltammetric pretreatment	
Start potential	-1.2 V
Vertex potential	-0.1 V
No. of cycles	50
Potentiostatic pretreatment	
Potential 1	-0.15 V
Waiting time 1	2 s
Potential 2	-1.3 V
Waiting time 2	180 s
Equilibration time	5 s

Sweep	
Start potential	-0.8 V
End potential	-0.1 V
Potential step	0.006 V
Potential step time	0.1 s
Sweep rate	0.06 V/s
Pulse amplitude	0.05 V
Pulse time	0.04 s

Comments

- The Hg plating solution can be reused several times (approx. 20 times). The solution itself is stable for at least one month. But with the number of plating processes the concentration of Hg in the solution decreases and the amount of contamination increases. Therefore the solution has to be replaced when no proper mercury film can be plated anymore.
- The waste Hg plating solution contains mercury. Therefore, care has to be taken for an appropriate disposal, in accordance with the local legislation.

Example curve for mercury plating



Determination of Zn

Analysis

10 mL (diluted) sample, 0.5 mL electrolyte and 0.1 mL Ga solution are pipetted into the measuring vessel. The measuring solution is purged for 5 min and the determination is carried out using the parameters given under «Parameters for determination of zinc».

The concentration of zinc is quantified by two additions of Zn standard solution.

Measuring solution

10 mL (diluted) sample

0.5 mL electrolyte

0.1 mL Ga solution

Standard addition

0.1 mL Zn standard solution 5 mg/L

Parameters for determination of zinc

Voltammetric	
Measuring mode	DP – Differential pulse
Stirring rate	2000 min ⁻¹
<i>Cyclovoltammetric pretreatment</i>	
Start potential	-1.4 V
Vertex potential	-0.7 V
No. of cycles	10
<i>Potentiostatic pretreatment</i>	
Potential 1	-0.1 V
Waiting time 1	5 s
Potential 2	-1.4 V
Waiting time 2	10 s
Equilibration time	5 s
<i>Sweep</i>	
Start potential	-1.2 V
End potential	-0.9 V
Potential step	0.004 V
Potential step time	0.1 s
Sweep rate	0.04 V/s
Pulse amplitude	0.05 V
Pulse time	0.04 s
<i>Potentiostat</i>	
Highest current range	2 mA

Lowest current range	20 µA
Substance	
Name	Zn
Characteristic potential	-1.05 V

Results

Average of 3 determinations with relative standard deviation.

Deposition time 30 s

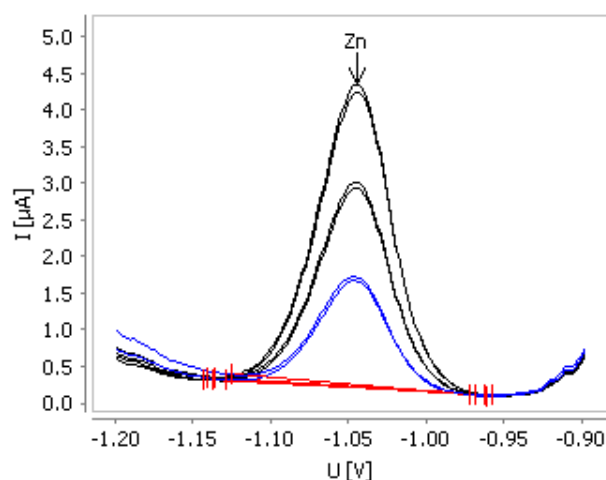
Sample	β(Zn)	Recovery
Check standard 5 µg/L	4.89 µg/L ± 1.7%	95.3%
Check standard 15 µg/L	14.57 µg/L ± 5.5%	97.2%
Certified reference material BCR-505*	10.73 µg/L ± 2.1%	95.4%

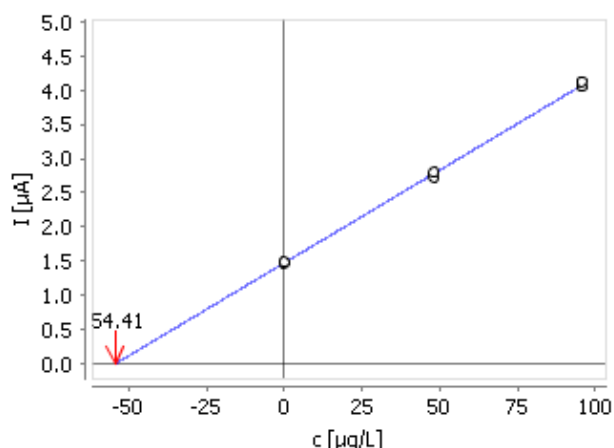
* reference value β(Zn) = 11.25 µg/L ± 0.72 µg/L

Deposition time 10 s

Sample	β(Zn)	Recovery
Check standard 10 µg/L	10.97 µg/L ± 2.7%	109.7%
Check standard 50 µg/L	51.99 µg/L ± 1.7%	104.0%
Check standard 100 µg/L	104.86 µg/L ± 0.6%	104.9%
Tap water	112.09 µg/L ± 2.7%	--

Example determination





Limit of detection and linear range

The limit of detection was determined using the «regression approach» [1], where the limit of detection is calculated as « $3 \cdot s_y$ », with s_y as the residual standard deviation of a linear regression. The linear working range was estimated from a calibration curve.

Deposition time	Limit of detection	Linear range
10 s	0.15 $\mu\text{g/L}$	300 $\mu\text{g/L}$
30 s	0.05 $\mu\text{g/L}$	40 $\mu\text{g/L}$

The limit of detection and linear range were determined in standard solutions. Depending on the condition of the electrode, quality of the mercury film or the sample matrix, these values can differ.

Assessment of mercury film

To test the quality of the mercury film it is recommended to run a determination in standard solution using the parameters given under «Parameters for determination of zinc». Measuring solution e.g.:

10 mL (diluted) sample

0.5 mL electrolyte

0.1 mL Ga solution

0.05 mL Zn standard solution $\beta(\text{Zn}) = 1 \text{ mg/L}$

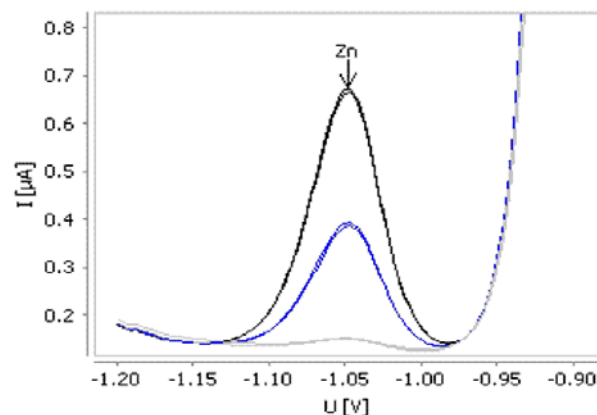
Assessment criteria

- The curve of the background current should be smooth.
- The background current should be stable.
- The replications should be reproducible.
- The peak maximum should not shift significantly.

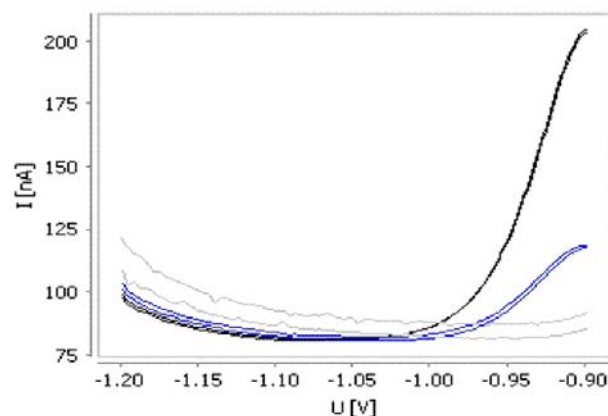
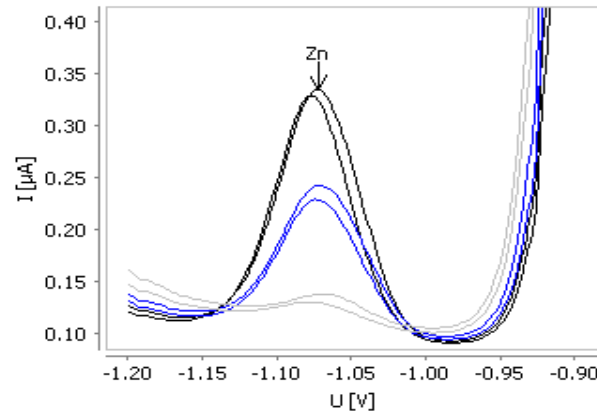
- The sensitivity should not be significantly lower than with a fresh mercury film.

If one of the criteria is not fulfilled it is recommended to remove the mercury film, carry out the cleaning and polishing procedure as described under «Preparation of the glassy carbon electrode» and plate a fresh mercury film.

Example for a determination with a good mercury film



Examples for determinations with a bad mercury film



Comments

- The increase in current at around -0.95 V is due to the presence of gallium.
- Under the given conditions the measuring solution contains 1 mg/L Ga. This concentration is sufficient to eliminate the interference of maximum 100 µg/L Cu. Higher concentrations of Ga should not be used since this can cause interferences, too. If a sample contains more than 100 µg/L Cu, it needs to be diluted for the determination.
- Deposition time and standard addition (volume and/or concentration of the standard solution) have to be adapted to the concentration of analyte in the measuring vessel. In this context it is important to consider the linear working range. For samples with concentrations between 10 and 150 µg/L it is recommended to use a deposition time of 10 s (Zn standard solution 5 mg/L). For samples with lower Zn content (<15 µg/L) it is recommended to increase the deposition time to 30 s (Zn standard solution 1 mg/L). Samples with concentrations between 10 µg/L and 15 µg/L can be analyzed with 10 s as well as with 30 s deposition time. Samples with concentrations >150 µg/L have to be diluted since a deposition time of 0 s has not proven useful.
- The mercury film can be used for half a day up to one day. But effects from the sample matrix can reduce the lifetime of the mercury film. Indications for a fading mercury film are:
 - bad reproducibility of the replications
 - decreasing sensitivity of the additions (slope)
 - increasing or noisy background current
 - peak is displaced

The mentioned indications can also be caused by matrix interferences. Therefore, in case of a suspicious mercury film, it is recommended to run a blank determination as described under «Assessment of mercury film» and to decide based on these curves whether the film needs to be renewed.

- If the mercury film is not used it is recommended to keep either diluted electrolyte or diluted nitric acid ($c(\text{HNO}_3) \sim 0.05 \text{ mol/L}$) in the measuring vessel. Storing the mercury film with ultrapure water is not recommended since it passivates the film.
- Care has to be taken that the nitrogen bubbles do not gaze the mercury film during purging. The bubbles can mechanically destroy the film. In this case the gas inlet tube has to be bent in a direction that the nitrogen does not bubble over the working electrode.

- To remove fouling from electrodes and measuring vessel it is recommended to clean with sulfuric acid from time to time. For that, fill 1–2 mL concentrated sulfuric acid into the slightly wet measuring vessel. Attention, the solution gets hot! Carefully turn the measuring vessel to wet the entire surface with H_2SO_4 . Then add 30–40 mL ultrapure water. Be very careful of splashing of the hot solution. Place the measuring vessel under the measuring head and turn on the stirring until the solution cooled down to room temperature. Empty the measuring vessel and rinse everything thoroughly with ultrapure water. Please note that this procedure is not suitable to remove metal blanks.
- Traces of metals can be removed with diluted nitric acid ($c(\text{HNO}_3) \sim 0.1 \text{ mol/L}$). For cleaning, place 20–30 mL diluted nitric acid in the measuring vessel and switch on the stirrer for 10–30 min. Empty the measuring vessel and rinse everything thoroughly with ultrapure water.

Determination of Zn, Cd and Pb

Zn can be determined together with Cd and Pb in one run, which is only advisable if the concentrations of the three elements are in the same range.

In many samples the concentration of zinc is significantly higher. In these cases Cd and Pb are favorably be determined with a separate method as described in Application Bulletin 241 [2].

Analysis

10 mL (diluted) sample and 0.5 mL electrolyte are pipetted into the measuring vessel. The measuring solution is purged for 5 min and the determination is carried out using the parameters given under «Parameters for determination of zinc, cadmium and lead».

The concentration of zinc is quantified by two additions of Zn, Cd and Pb standard solution(s).

Measuring solution

10 mL (diluted) sample

0.5 mL electrolyte

0.1 mL Ga solution

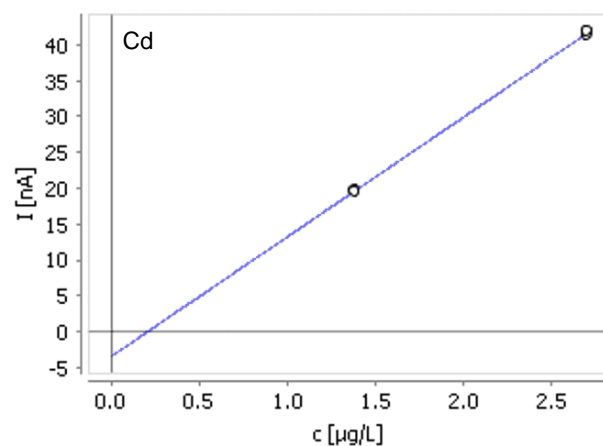
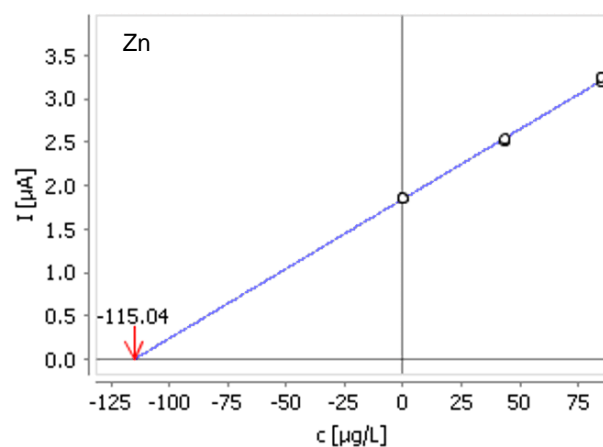
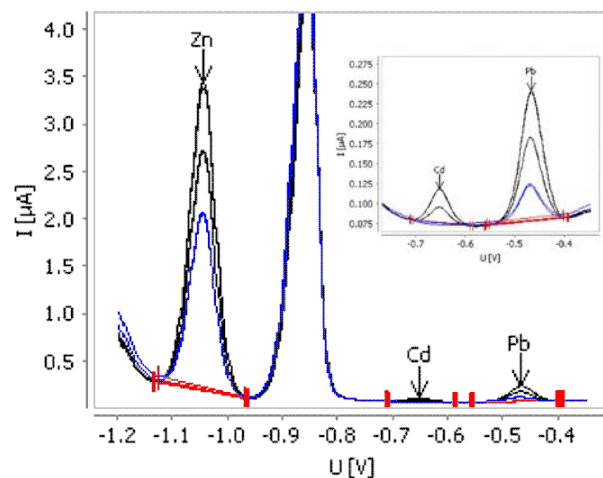
Parameters for determination of zinc, cadmium and lead

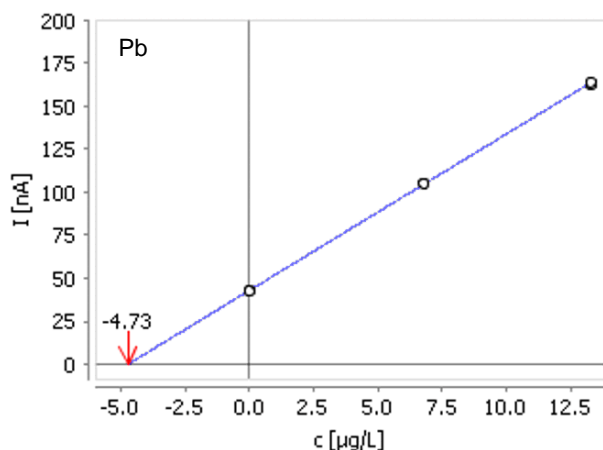
Voltammetric	
Measuring mode	DP – Differential pulse
Stirring rate	2000 min ⁻¹
Cyclovoltammetric pretreatment	
Start potential	-1.4 V
Vertex potential	-0.7 V
No. of cycles	10
Potentiostatic pretreatment	
Potential 1	-0.1 V
Waiting time 1	5 s
Potential 2	-1.4 V
Waiting time 2	10 s
Equilibration time	5 s
Sweep	
Start potential	-1.2 V
End potential	-0.35 V
Potential step	0.004 V
Potential step time	0.1 s
Sweep rate	0.04 V/s
Pulse amplitude	0.05 V
Pulse time	0.04 s
Potentiostat	
Highest current range	2 mA
Lowest current range	20 µA
Substance	
Name	Zn
Characteristic potential	-1.05 V
Name	Cd
Characteristic potential	-0.65 V
Name	Pb
Characteristic potential	-0.46 V

Results

Sample	β(Zn)	β(Cd)	β(Pb)
Tap water	121.94 µg/L	n/a	5.01 µg/L

Example





Comments

- The huge signal between -0.95 V and -0.8 V is caused by the added gallium.
- For more information on the determination of cadmium and lead please refer to Application Bulletin 241 [2].
- The determination of copper at the mercury film electrode is generally not possible, since the calibration curve is not linear.

References

- [1] J. Mocak, A. Bond, S. Mitchell and G. Scollary, "A statistical overview of standard (IUPAC and ACS) and new procedures for determining the limits of detection and quantification: Application to voltammetric and stripping techniques," *Pure and Applied Chemistry*, vol. 69, no. 2, pp. 297-328, 1997.
- [2] Metrohm AG, «Application Bulletin 241 - Determination of cadmium and lead by anodic stripping voltammetry at a mercury film electrode».

Appendix

Report of the example determination Zn in tap water



Result report

page 1 of 3

2017-10-10 10:00:31

zu

Determination

Determination start 2017-10-05 15:49:12 UTC+2
User name (short) zu
User name Barbara Zümbrägel
Methodenname AB 254 Determination of Zn_10sDep_auto add

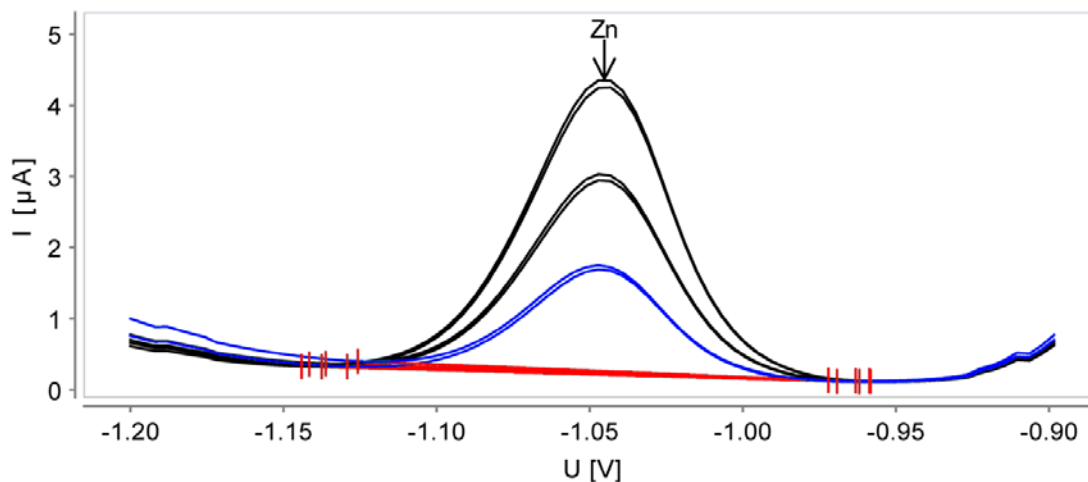
Sample data

Sample type Sample
ID 1 Tap water MIHQ (03.10.2017 15:25)
ID 2 10 mL H₂O + 0.5 mL NH₄Ac/KCl + 0.1 mL Ga (100 mg/L)
ID 3 GC 00793502, RE 00445983, AE 00843004
Sample amount 10.0 mL
Analytical volume
Dilution volume

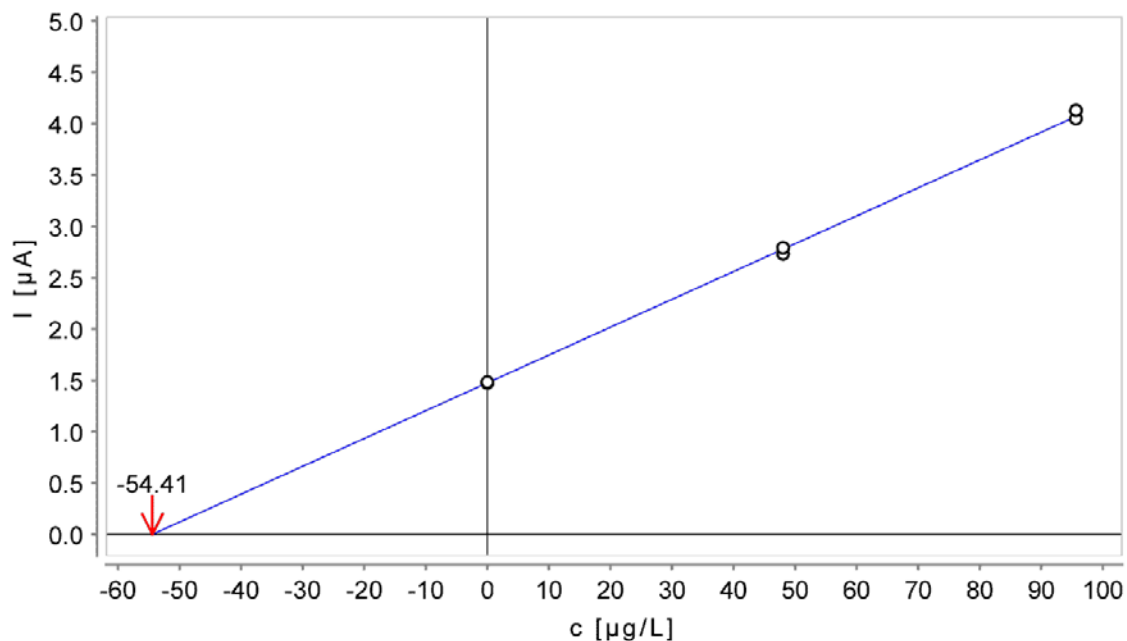
Results overview

ASV.Zn.Concentration 112.09 µg/L
ASV.Zn.Concentration.ASD 2.30 µg/L
ASV.Zn.Concentration.RSD 2.1 %

ASV



ASV (Zn)



Concentration 112.09 µg/L
 Absolute standard deviation 2.30 µg/L
 Relative standard deviation 2.1 %
 Function $y = 1.476E-6 + 2.713E-2 \cdot x$
 Coefficient of determination R^2 0.99907
 Evaluation quantity Height
 Curve type Linear regression
 Weighting used

CALL	Var	Rep	Peak potential [V]	Height [µA]	Used
Measure sample	1	1	-1.047	1.48	used
Measure sample	1	2	-1.046	1.47	used
Measure additions	2	1	-1.046	2.79	used
Measure additions	2	2	-1.046	2.73	used
Measure additions	3	1	-1.045	4.13	used
Measure additions	3	2	-1.045	4.05	used

ASV (Zn)

CALL	VAR	REP	POT	HGT	HGT.MNV	HGT.ASD	HGT.RSD	HGT.MNVDELTA
			V	µA	µA	nA	%	µA
Measure sample	1	1	-1.047	1.48	1.48	6.65	0.4	0.00
Measure sample	1	2	-1.046	1.47	1.48	6.65	0.4	0.00
Measure additions	2	1	-1.046	2.79	2.76	42.13	1.5	1.28
Measure additions	2	2	-1.046	2.73	2.76	42.13	1.5	1.28
Measure additions	3	1	-1.045	4.13	4.09	56.79	1.4	1.33
Measure additions	3	2	-1.045	4.05	4.09	56.79	1.4	1.33

Report of the example determination Zn, Cd, Pb in tap water



Result report

page 1 of 5

2017-10-10 13:47:35

zu

Determination

Determination start 2017-10-10 12:42:26 UTC+2
User name (short) zu
User name Barbara Zumbrägel
Methodenname AB 254 Determination of ZnCdPb_auto add

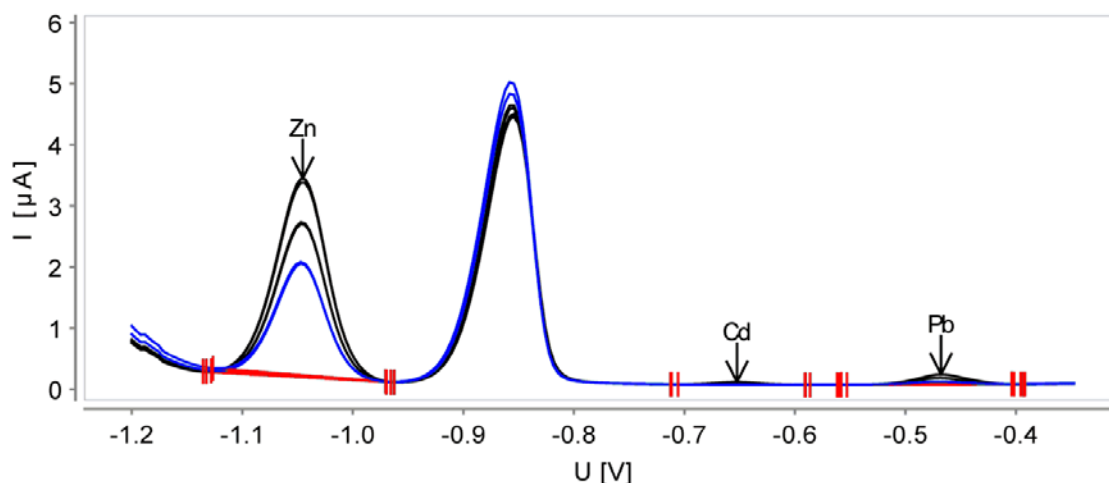
Sample data

Sample type Sample
ID 1 Tap water Zn, Cd, Pb
ID 2 10 mL sample + 0.5 mL NH₄Ac/KCl + 0.1 mL Ga (100 mg/L)
ID 3 GC 00793502, RE 00445983, AE 00843004
Sample amount 10.0 mL
Analytical volume
Dilution volume

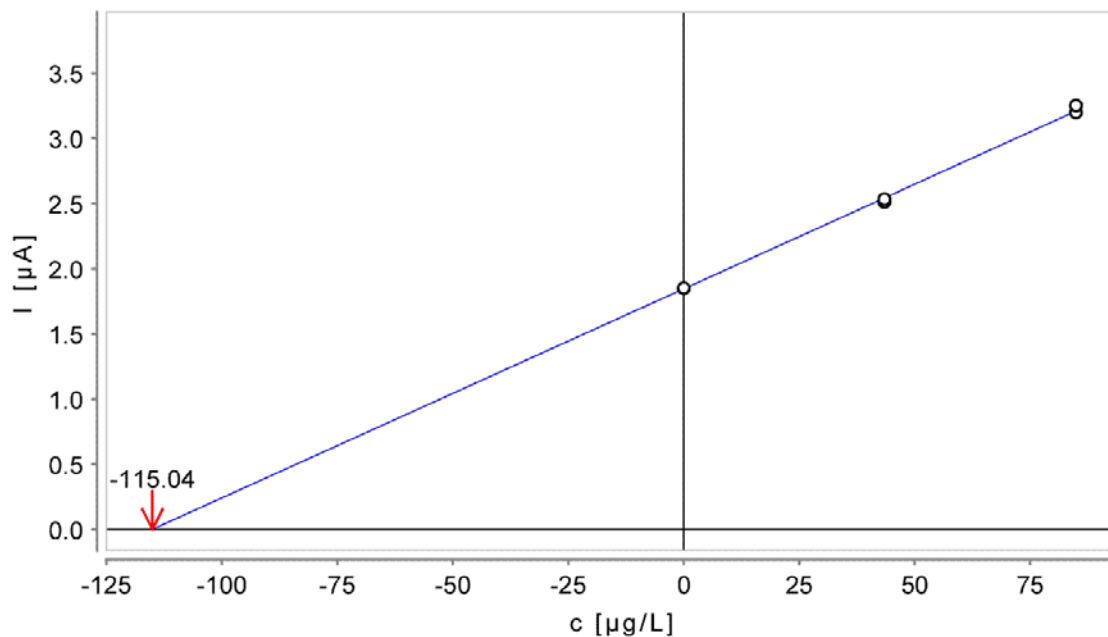
Results overview

ASV.Zn.Concentration	121.94	µg/L
ASV.Cd.Concentration	invalid	
ASV.Pb.Concentration	5.012	µg/L
ASV.Zn.Concentration.ASD	2.94	µg/L
ASV.Zn.Concentration.RSD	2.4	%
ASV.Cd.Concentration.ASD	invalid	
ASV.Cd.Concentration.RSD	invalid	
ASV.Pb.Concentration.ASD	49.984	ng/L
ASV.Pb.Concentration.RSD	1.0	%

ASV



ASV (Zn)



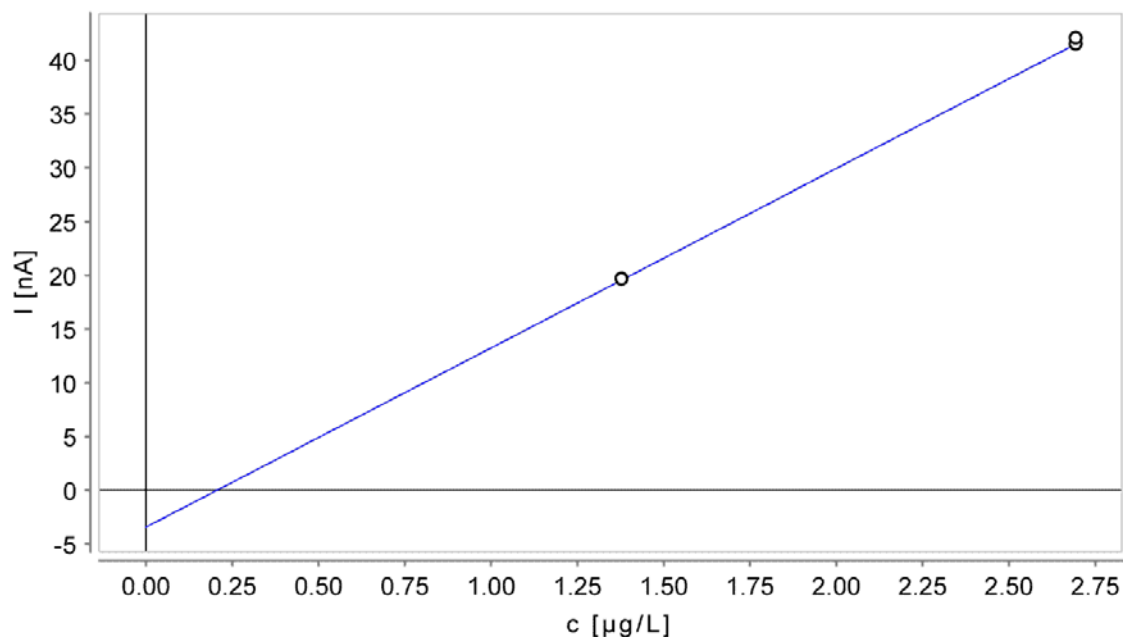
Concentration 121.94 μg/L
Absolute standard deviation 2.94 μg/L
Relative standard deviation 2.4 %
Function $y = 1.845E-6 + 1.604E-2 \cdot x$
Coefficient of determination R^2 0.99835
Evaluation quantity Height
Curve type Linear regression
Weighting used

CALL	Var	Rep	Peak potential [V]	Height [μA]	Used
Measure sample	1	1	-1.047	1.85	used
Measure sample	1	2	-1.046	1.85	used
Measure additions	2	1	-1.046	2.53	used
Measure additions	2	2	-1.046	2.51	used
Measure additions	3	1	-1.045	3.25	used
Measure additions	3	2	-1.045	3.20	used

ASV (Zn)

CALL	VAR	REP	POT	HGT	HGT.MNV	HGT.ASD	HGT.RSD	HGT.MNVDELTA
			V	μA	μA	nA	%	nA
Measure sample	1	1	-1.047	1.85	1.85	1.58	0.1	0.00
Measure sample	1	2	-1.046	1.85	1.85	1.58	0.1	0.00
Measure additions	2	1	-1.046	2.53	2.52	16.07	0.6	672.48
Measure additions	2	2	-1.046	2.51	2.52	16.07	0.6	672.48
Measure additions	3	1	-1.045	3.25	3.22	39.06	1.2	701.10
Measure additions	3	2	-1.045	3.20	3.22	39.06	1.2	701.10

ASV (Cd)



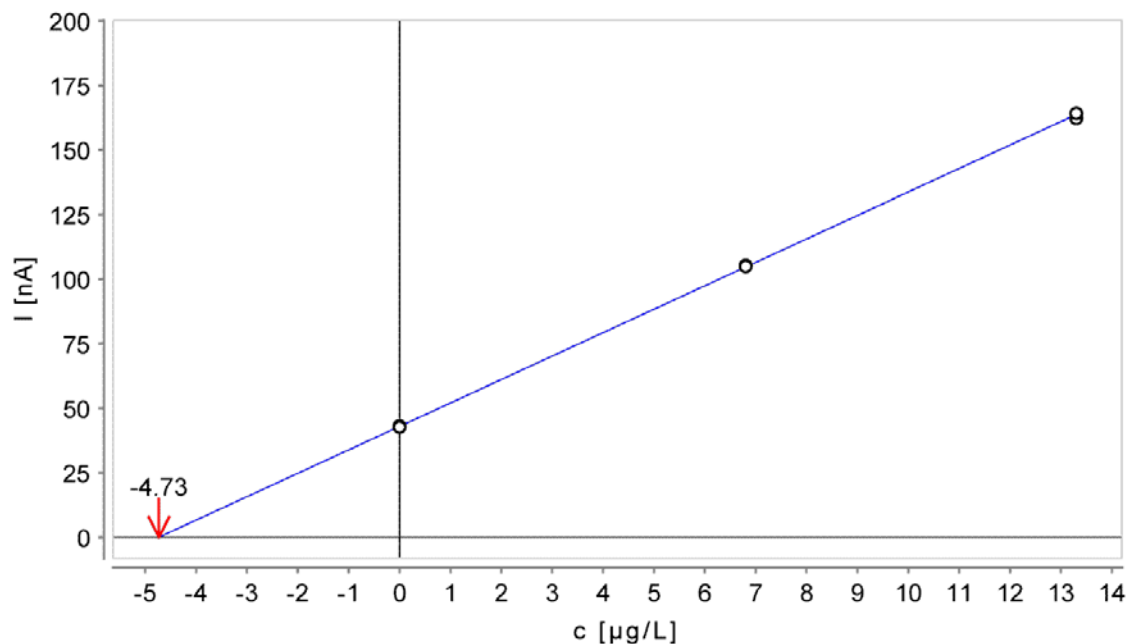
Function $y = -3.443\text{E-}9 + 1.669\text{E-}2 \cdot x$
Coefficient of determination R^2 0.99966
Evaluation quantity Height
Curve type Linear regression
Weighting used

CALL	Var	Rep	Peak potential [V]	Height [nA]	Used
Measure sample	1	1			used
Measure sample	1	2			used
Measure additions	2	1	-0.653	19.68	used
Measure additions	2	2	-0.653	19.74	used
Measure additions	3	1	-0.652	42.11	used
Measure additions	3	2	-0.652	41.54	used

ASV (Cd)

CALL	VAR	REP	POT	HGT	HGT.MNV	HGT.ASD	HGT.RSD	HGT.MNVDELTA
			V	nA	nA	pA	%	nA
Measure sample	1	1						
Measure sample	1	2						
Measure additions	2	1	-0.653	19.68	19.71	37.20	0.2	0.00
Measure additions	2	2	-0.653	19.74	19.71	37.20	0.2	0.00
Measure additions	3	1	-0.652	42.11	41.82	406.44	1.0	22.11
Measure additions	3	2	-0.652	41.54	41.82	406.44	1.0	22.11

ASV (Pb)



Concentration 5.012 µg/L
Absolute standard deviation 0.050 µg/L
Relative standard deviation 1.0 %
Function $y = 4.293E-8 + 9.078E-3 \cdot x$
Coefficient of determination R^2 0.99980
Evaluation quantity Height
Curve type Linear regression
Weighting used

CALL	Var	Rep	Peak potential [V]	Height [nA]	Used
Measure sample	1	1	-0.471	42.66	used
Measure sample	1	2	-0.471	43.13	used
Measure additions	2	1	-0.469	104.91	used
Measure additions	2	2	-0.469	105.32	used
Measure additions	3	1	-0.468	164.12	used
Measure additions	3	2	-0.468	162.19	used

ASV (Pb)

CALL	VAR	REP	POT	HGT	HGT.MNV	HGT.ASD	HGT.RSD	HGT.MNVDELTA
			V	nA	nA	nA	%	nA
Measure sample	1	1	-0.471	42.66	42.89	0.33	0.8	0.00
Measure sample	1	2	-0.471	43.13	42.89	0.33	0.8	0.00
Measure additions	2	1	-0.469	104.91	105.12	0.29	0.3	62.22
Measure additions	2	2	-0.469	105.32	105.12	0.29	0.3	62.22
Measure additions	3	1	-0.468	164.12	163.15	1.37	0.8	58.04
Measure additions	3	2	-0.468	162.19	163.15	1.37	0.8	58.04