Polarography, voltammetry and CVS
Polarography, voltammetry and CVS

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Trace analysis with voltammetry
Determination of total metal and metal species

Voltammetry instruments from Metrohm are modest in terms of servicing requirements, procurement price and dimensions, but nonetheless great in their detection capabilities.

Traces of toxic heavy metals can be analyzed in extremely low concentrations without great effort. The detection limits are to be found without exception in the ppt range, which means that the necessary sensitivity can be achieved in all cases. Voltammetry is one of the few methods in existence for the speciation of analytes.

Metal analyses can be carried out with equivalent or better sensitivity, at a fraction of the procurement price of an AAS or ICP instrument. An additional plus for voltammetry are the low costs of ownership. Except for small quantities of reagents, only tiny amounts of high-purity nitrogen are required. No expensive flammable gases, no conversion of the laboratory with special gas supply and flue gas outlets, no expensive lamps and no time-consuming calibration of the analysis system.

Applications that convince

Analysis of traces of metals
In addition to the determination of total concentrations, as is usual with spectroscopic methods, with voltammetry it is also possible to specify between the different oxidation stages of metal ions or the biological availability of heavy metals. A distinction can be made between free and bound metal ions. This makes voltammetry an indispensable element of environmental analysis. It is not possible for spectroscopy to yield comparable statements except after tedious separation of the metal species. Thanks to its compact dimensions, the instrument can also be used in mobile laboratories.

Samples with high ion concentrations present no problem for voltammetry. Voltammetry is predestined for the analysis of:

- Water, waste water and sea water
- Foods
- Salts, pure chemicals
- Galvanic baths

Specific analysis of organics
It is not only metals that can be determined, but also various organic compounds. The technology is used in organic chemistry, e.g. for the analysis of contaminations, or in pharmaceutical chemistry for the determination of active ingredient concentrations.

Examples of interesting determinations:

- 4-carboxybenzaldehyde in terephthalic acid
- Free styrol in polystyrene
- Vitamins in juices, vitamin preparations

Determination of anions
Some anions can also be determined with voltammetry. Of particular interest is the analysis of the species cyanide, sulfide, nitrite, nitrate and iodide.

<table>
<thead>
<tr>
<th>Ion</th>
<th>Detection Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sb(^{III}) / Sb(^{V})</td>
<td>200 ppt</td>
</tr>
<tr>
<td>As(^{III}) / As(^{V})</td>
<td>100 ppt</td>
</tr>
<tr>
<td>Bi</td>
<td>500 ppt</td>
</tr>
<tr>
<td>Cd</td>
<td>50 ppt</td>
</tr>
<tr>
<td>Cr(^{II}) / Cr(^{VI})</td>
<td>25 ppt</td>
</tr>
<tr>
<td>Co</td>
<td>50 ppt</td>
</tr>
<tr>
<td>Cu</td>
<td>50 ppt</td>
</tr>
<tr>
<td>Fe(^{II}) / Fe(^{III})</td>
<td>50 ppt</td>
</tr>
<tr>
<td>Pb</td>
<td>50 ppt</td>
</tr>
<tr>
<td>Hg</td>
<td>100 ppt</td>
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<td>Mo</td>
<td>50 ppt</td>
</tr>
<tr>
<td>Ni</td>
<td>50 ppt</td>
</tr>
<tr>
<td>Pt</td>
<td>0.1 ppt</td>
</tr>
<tr>
<td>Rh</td>
<td>0.1 ppt</td>
</tr>
<tr>
<td>Se(^{IV}) / Se(^{VI})</td>
<td>300 ppt</td>
</tr>
<tr>
<td>Tl</td>
<td>50 ppt</td>
</tr>
<tr>
<td>W</td>
<td>200 ppt</td>
</tr>
<tr>
<td>U</td>
<td>25 ppt</td>
</tr>
<tr>
<td>Zn</td>
<td>50 ppt</td>
</tr>
</tbody>
</table>

1 ppt = part per trillion = 1 ng/kg

Typical detection limits in voltammetric trace analysis
The 797 VA Computrace for trace analysis

The 10 most important benefits

- Voltammetric trace analysis and additive determination in galvanics with a single instrument
- Maximum sensitivity thanks to the combination of the unique Multi-Mode Electrode pro with the installed potentiostat
- Automation with the 863 Compact VA Autosampler or the 838 Advanced VA Sample Processor
- Archiving of the data in the Autodatabase program with report generator
- More than 220 important analysis methods are included in the scope of delivery
- Output of the result in an unlimited number of formats
- Unique EXPLORATORY mode, specially designed for education at schools and universities
- Metrohm monographs „Introduction to Polarography and Voltammetry“ and „Practical Voltammetry“
- Built-in quality assurance with GLP mode, access rights for each user and automatic electrode test
- Simple operation using the clearly organized user interface oriented to the Windows operating concept
- Connection to the USB port of the PC

The 797 VA Computrace is a modern voltammetric measuring stand that is connected to a PC via a USB port. The computer software provided controls the measurement, records the measured data and evaluates it. Operation is most straightforward due to the well-laid-out structure of the program. The integrated potentiostat with galvanostat guarantees the highest sensitivity with reduced noise.

Voltammetry system for trace analysis and education. Complete accessories with VA Computrace software and all electrodes for a complete measurement system: Multi-Mode Electrode pro (MME pro), Ag/AgCl reference electrode and Pt auxiliary electrode.

797 VA Computrace – Manual or automated

The 797 VA Computrace is a completely functional analysis system for meeting the highest expectations in terms of accuracy and sensitivity. All solutions are added manually. The various extension options, e.g., Dosinos or the additions of auxiliary and standard solutions, sample changer and automatic rinsing provide greater convenience.

Ordering Information

2.797.0010 797 VA Computrace for trace analysis
797 VA Computrace with automatic standard addition for trace analysis

Easy to operate, partially automated analysis system for voltammetric trace analysis and education, comprised of 797 VA Computrace with two 800 Dosinos for the automatic addition of auxiliary solutions. The computer software provided controls the measurement, records the measured data and evaluates it. Operation is most straightforward due to the well-laid-out structure of the program. The integrated potentiostat with galvanostat guarantees the highest sensitivity with reduced noise.

Partially automated voltammetry system for inexpensive convenience
Two auxiliary solutions can be added automatically to the measuring vessel. Calibration in voltammetry is accomplished by means of standard addition or calibration curve and is carried out automatically by one of the 800 Dosinos. The second 800 Dosino adds the electrolytes or buffer automatically. The Dosinos are completely controlled by the 797 VA Computrace. One additional 800 Dosino can be connected directly, as can four additional ones by using an 846 Dosing Interface. A maximum of seven 800 Dosinos can thus be used.

The sample is handled manually. The sample is added in the measuring vessel by using a pipette and the analysis is started. This system is intended for users who value elegant and convenient operation at an attractive price without having to use a sample changer.

Complete accessories in the scope of delivery with VA Computrace software and all electrodes for a complete measurement system: Multi-Mode Electrode pro (MME pro), Ag/AgCl reference electrode and Pt auxiliary electrode.
797 VA Computrace fully automated for trace analysis

Fully automated analysis system for voltammetric trace analysis and education, comprised of 797 VA Computrace with 863 Compact VA Autosampler and two 800 Dosinos for the automatic addition of auxiliary solutions. The computer software provided controls the measurement, records the measured data and evaluates it. Operation is most straightforward due to the well-laid-out structure of the program. The integrated potentiostat with galvanostat guarantees the highest sensitivity with reduced noise.

**Fully automated voltammetry system**

Up to 18 samples can be investigated automatically, precisely and reproducibly. The software of the 797 VA Computrace controls the complete analysis sequence. The samples are placed on the sample rack of the 863 Compact VA Autosampler, and the rest takes place automatically: the transfer of the samples into the measuring vessel with the built-in peristaltic pump, the voltammetric determination with the automatic addition of all of the auxiliary solutions by using two 800 Dosinos and the automatic rinsing with the 843 Pump Station. The reproducible and efficient rinse minimizes carry-overs and thus enhances the accuracy of the determinations. In order to increase the number of auxiliary solutions, one additional 800 Dosino can be connected directly, as can four additional ones by using an 846 Dosing Interface. A maximum of seven 800 Dosinos can thus be used.

This system is the optimum solution for the automatic analysis of small sample series that must be analyzed for one or two analytes in a single analysis run.

Complete accessories in the scope of delivery with VA Computrace software and all electrodes for a complete measurement system: Multi-Mode Electrode pro (MME pro), Ag/AgCl reference electrode and Pt auxiliary electrode.
Electrode kits for trace analysis

**MVA-Hg, equipment for mercury determination (6.5327.000)**

Complete set of accessories for the determination of mercury as per Application Bulletin 96. Contains rotating gold working electrode, reference electrode, glassy-carbon auxiliary electrode and other accessories.

**scTRACE Gold equipment (6.5340.000)**

Complete accessories kit for the determination of arsenic with the scTRACE Gold as described in Application Bulletin 416. Contains electrode holder, scTRACE Gold (4 pieces), measuring vessel, stirrer and additional accessories.
Sample preparation for trace analysis
909 UV Digester (230 V)

- Control unit and wet end in a single housing
- Digital input of digestion temperature and digestion time
- Microprocessor-controlled regulation of digestion temperature and digestion time
- Air cooling
- Digestion of up to 12 samples simultaneously
- Short digestion times
- Largely blank value-free, as only very small amounts of reagents are required
- Also suitable for elements that form highly volatile compounds, e.g., mercury, arsenic and selenium

Digestion is indispensable for the reliable determination of traces and ultratrace metals in natural samples, as organic sample components are generally disruptive to analysis. The 909 UV Digester was designed for the digestion of suspended particle-free water samples containing low to medium contents of organic material, e.g., natural surface waters. As a result of its low heavy metal content, contaminations can very easily lead to disruptions during determination. Liquid biological samples such as urine or some foodstuffs such as fruit juices and alcoholic beverages can however also be digested with a modified procedure. A great advantage of the UV digestion is that only small amounts of digestion reagents need to be used and therefore the blank values can be kept low.

12 samples can be radiated simultaneously in the 909 UV Digester.

Ordering Information
2.909.0014 909 UV Digester (230 V)
CVS – Cyclic Voltammetric Stripping

Introduction CVS

Cyclic Voltammetric Stripping Analysis (CVS) and Cyclic Pulse Voltammetric Stripping Analysis (CPVS) are methods widely used in the electroplating industry for the determination of organic additives in electroplating baths. A robust, inexpensive rotating disk electrode of simple construction made of platinum is installed in the VA stand for these analyses in place of the Multi-Mode electrode that is otherwise used. This method is an indispensable part of production control for many types of technical coatings and particularly in the manufacturing of printed circuit boards for electronic equipment. The most important fields of application are acidic copper baths and tin-lead baths. Quantitative determination of the additives takes place indirectly via their influence on the plating of the main component of the electroplating bath. As the measurement utilizes a procedure that corresponds to the production process, the activity of the additives and thus their effectiveness in the electroplating process is measured directly.

The quantification of the various types of additives requires special calibration techniques, all of which are available in Metrohm CVS systems. The so-called brighteners are determined with the aid of the Linear Approximation Technique (LAT) or the Modified Linear Approximation Technique (MLAT). Dilution Titration (DT) is used for the determination of the suppressors while levelers are determined via Response Curve (RC).

The concentrations of the additives can be determined exactly with CVS or CPVS. The effective concentration of the respective additive in the bath sample is displayed and printed out directly in mL of additive per L of bath. Topping-up to achieve nominal concentration thus can be carried out very precisely as a result. This guarantees a continuous, malfunction-free production process. The accuracy of the analysis results in particular have led to the general acceptance of the method in the electroplating industry.

Other methods, e.g., the classical Hull cell method, do not allow the concentration to be determined, but only provide an assessment of the quality of the deposited metal layer.

One of the pre-installed methods is loaded to perform the determination. The analysis can be started once a few parameters have been adjusted. Pre-finished methods that have been formulated in our Applications Laboratory for the most important bath types of leading manufacturers are supplied along with the instrument.
The most important benefits
- Compact instrument with small installation area
- Measuring head that can be replaced with a single hand movement
- Built-in certified calibrator for automatic instrument adjustment before each measurement
- Flexible Liquid Handling with 800 Dosinos
- Flexible automation options with 858 Professional Sample Processor, 919 IC Autosampler plus and 843 Pump Station
- Connection to the USB port of the PC

894 Professional CVS manual is the introductory instrument for the high-end determinations of organic additives in electroplating baths with „Cyclic Voltammetric Stripping“ (CVS). The proven Metrohm electrode technique in combination with a completely newly designed potentiostat/galvanostat and the extremely high-performance viva software opens up new perspectives in CVS. The replaceable measuring head enables rapid changes between various applications with different electrodes. The potentiostat with certified calibrator readjusts itself automatically before each measurement and guarantees a maximum in precision.

The viva software is required for control, data recording and evaluation.

The 894 Professional CVS manual is supplied with extensive accessories and measuring head for rotating disk electrodes. Electrode set and viva license are to be ordered separately.

Manual system with versatile extension options
With the appropriate electrode set, the 894 Professional CVS manual is a completely functional analysis system for meeting the highest expectations in terms of accuracy and sensitivity. The measurement system offers maximum flexibility through modular extension options and the practically unlimited configurability available with the viva software.

viva
The Professional CVS system is controlled with viva. The new software for CVS offers previously unachieved flexibility with respect to method adjustment and automation and thus sets new standards in the determination of organic additives with CVS. viva is available in a single-user version or as a network option for one client-server installation.

Ordering Information
2.894.0210 894 Professional CVS manual
894 Professional CVS semiautomated

**The most important benefits**
- Compact instrument with small installation area
- Two 800 Dosinos for the automatic addition of auxiliary solutions
- Liquid Handling can be extended without limit with additional 800 Dosinos
- Measuring head that can be replaced with a single hand movement
- Built-in certified calibrator for automatic instrument adjustment before each measurement
- Flexible automation options with 858 Professional Sample Processor, 919 IC Autosampler plus and 843 Pump Station
- Connection to the USB port of the PC

894 Professional CVS semiautomated is a convenient high-end routine analyzer for determinations of organic additives in electroplating baths with „Cyclic Voltammetric Stripping“ (CVS). The proven Metrohm electrode technique in combination with a completely newly designed potentiostat/galvanostat and the extremely high-performance viva software opens up new perspectives in CVS. The replaceable measuring head enables rapid changes between various applications with different electrodes. The potentiostat with certified calibrator readjusts itself automatically before each measurement and guarantees a maximum in precision.

Two 800 Dosinos (supplied) permit the automatic addition of auxiliary solutions during the determination, e.g., VMS, standard solutions or samples for the Dilution Titration technique (DT).

The **viva** software is required for control, data recording and evaluation.

The 894 Professional CVS semiautomated is supplied with extensive accessories and measuring head for rotating disk electrodes. Electrode set and **viva** license are to be ordered separately.

**Convenient routine measurements**
With the appropriate electrode set, the 894 Professional CVS semiautomated enables the determination of suppressors with Dilution Titration (DT). All solutions are added automatically during the determination by the two supplied 800 Dosinos, e.g., VMS, standard solutions or samples for the Dilution Titration technique (DT). The determination proceeds automatically, from the preparation of the sample to the calculation of the final result. The performance capability can be further increased through modular extension options and the practically unlimited configurability available with the **viva** software.

**viva**
The Professional CVS system is controlled with **viva**. The new software for CVS offers previously unachieved flexibility with respect to method adjustment and automation and thus sets new standards in the determination of organic additives with CVS. **viva** is available in a single-user version or as a network option for one client-server installation.

**Ordering Information**
2.894.1210 894 Professional CVS semiautomated
894 Professional CVS fully automated for small sample series

Automated analysis system for the determination of organic additives in electroplating baths using the CVS technique (“Cyclic Voltammetric Stripping”). Comprised of 894 Professional CVS, 919 IC Autosampler plus, four 800 Dosinos, 843 Pump Station, measuring head for rotating disk electrodes and extensive accessories. For small sample series of up to 14 samples.

The viva software is required for control, data recording and evaluation. PC, electrode set and viva license are to be ordered separately.

**Fully automated analysis system for the determination of organic additives with CVS in routine laboratory work**

MVA-20 is the version in our top system for fully automated additive determination in electroplating baths with CVS (Cyclic Voltammetric Stripping) for small sample series. Up to 27 samples can be investigated with respect to suppressor content with the 919 IC Autosampler plus. Up to 14 samples can be analyzed automatically during brightener determination. The possibility of recalibrating methods during a sample series guarantees the highest of accuracy. And different methods can be combined in a single measurement sequence.

The system is based on the 894 Professional CVS with four 800 Dosinos for the automatic addition of auxiliary solutions. VMS and the electroplating bath sample are added by using 800 Dosinos in cases of suppressor determination. For the determination of brighteners, the intercept solution and brightener standard solution are added by 800 Dosino dosing systems; the peristaltic pump of the 919 IC Autosampler plus is used for transferring the sample automatically from the sample vessel on the sample rack into the measuring vessel on the 894 Professional CVS. The attached 843 Pump Station empties and rinses the measuring vessel automatically after each sample.

The Professional CVS system is controlled with viva. The new software for CVS offers previously unachieved flexibility with respect to method adjustment and automation and thus sets new standards in the determination of organic additives with CVS. viva is available in a single-user version or as a network option for one client-server installation.
894 Professional CVS fully and flexibly automated for large sample series

Automated analysis system for high-performance, flexible determination of organic additives in electroplating baths using the CVS technique („Cyclic Voltammetric Stripping“). Comprised of 894 Professional CVS, 858 Professional Sample Processor, four 800 Dosinos, 843 Pump Station, measuring head for rotating disk electrodes and extensive accessories. For sample series of up to 56 samples.

The viva software is required for control, data recording and evaluation. PC, electrode set and viva license are to be ordered separately.

Fully automated analysis system for the determination of organic additives with CVS in routine laboratory work

MVA-21 is the version in our top system for fully automated additive determination in electroplating baths with CVS (Cyclic Voltammetric Stripping) for large sample series. Up to 56 samples can be investigated with respect to suppressor content with the 858 Professional Sample Processor. Up to 28 samples can also be analyzed automatically during brightener determination. The possibility of recalibrating methods during a sample series guarantees the highest of accuracy. And different methods can be combined in a single measurement sequence.

The system is based on the 894 Professional CVS with four 800 Dosinos for the automatic addition of auxiliary solutions. VMS and the electroplating bath sample are added by using 800 Dosinos in cases of suppressor determination. For the determination of brighteners, the intercept solution and brightener standard solution are added by 800 Dosino dosing systems; the peristaltic pump of the 858 Professional Sample Processor is used for transferring the sample automatically from the sample vessel on the sample rack into the measuring vessel on the 894 Professional CVS. The attached 843 Pump Station empties and rinses the measuring vessel automatically after each sample.

viva

The Professional CVS system is controlled with viva. The new software for CVS offers previously unachieved flexibility with respect to method adjustment and automation and thus sets new standards in the determination of organic additives with CVS. viva is available in a single-user version or as a network option for one client-server installation.

Ordering Information

| MVA-21 | 894 Professional CVS fully and flexibly automated for large sample series |

Polarography, voltammetry and CVS
Electrode kits for CVS

CVS electrode equipment with 1 mm platinum electrode for Professional CVS instruments
(6.5339.000)
Complete electrode set for the determination of organic additives in electroplating baths with CVS (Cyclic Voltammetric Stripping). Contains rotating platinum working electrode (electrode diameter: 1 mm), reference electrode, platinum auxiliary electrode and electrolyte solutions.

CVS electrode equipment with 2 mm platinum electrode for Professional CVS instruments
(6.5339.010)
Complete electrode set for the determination of organic additives in electroplating baths with CVS (Cyclic Voltammetric Stripping). Contains rotating platinum working electrode (electrode diameter: 2 mm), reference electrode, platinum auxiliary electrode and electrolyte solutions.

CVS electrode equipment with 3 mm platinum electrode for Professional CVS instruments
(6.5339.020)
Complete electrode set for the determination of organic additives in electroplating baths with CVS (Cyclic Voltammetric Stripping). Contains rotating platinum working electrode (electrode diameter: 3 mm), reference electrode, platinum auxiliary electrode and electrolyte solutions.
Modern, user-friendly software for the performance of CVS determinations. Thanks to its easy operation and maximum flexibility, viva enables individual and problem-oriented method programming for CVS measuring technology for the first time.

The „Workplace“ program part is the cockpit of viva. Here all of the information necessary for the determination is visible at a glance. It goes without saying that the „Workplace“ can be individually configured so that only the data relevant to the user is displayed. The method used and the associated evaluation parameters are logically structured and clearly displayed in the method window. The measured voltammograms and the associated calibration curve are displayed in the curve window.

viva is the first and only software for CVS that enables individual, problem-oriented method programming with the aid of a graphical method editor. Numerous templates simplify method development. The intelligence functions of viva make it possible to have the run of the method be made dependent on results of the current measurement that have already been calculated. Thus, for example, standard addition volumes can be calculated autonomously.

All determinations are stored in a database for convenient data management where they can be viewed along with all of the determination, method and instrument parameters.

**The most important features at a glance:**
- Freely configurable determination overview
- High-performance sort, search and filter functions that are simple to operate
- Recalculation and recalibration functions
- Report generator for customized structuring of the analysis report
- Client-server version for the central storage of all methods and determinations on a single server. All measured data is thus available throughout the company
- Freely definable access permissions for each user

viva is available in the viva Full single-user version with 1 license for one computer. The alternative is the viva Multi client-server version with 3 licenses for three computers for company networks, which makes it possible to store all of the data on a central server. Separate licenses can be obtained for additional computers.

**Ordering Information**
- 6.6065.102 viva 1.0 Full CD: 1 license
- 6.6065.103 viva 1.0 Multi CD: 3 licenses
Portable potentiostat
910 PSTAT mini

- Small and compact
- Mobile
- Inexpensive
- All of the important electrochemical measurement techniques
- Maintenance-free disposable sensors
- Power supply via USB
- Simple, intuitive PSTAT software
- Monograph „Electrochemistry – A workbook for 910 PSTAT mini”

The ideal introductory instrument for electrochemistry
910 PSTAT mini is a small and compact, PC-controlled potentiostat with USB connector for training purposes as well as simple applications in research and development. The PSTAT software provided is easy and intuitive to operate and covers the most important electrochemical measuring techniques. Included in the scope of delivery are inexpensive disposable thick film sensors that can be utilized directly, without preparation and conditioning.

The 910 PSTAT mini is supplied with extensive accessories in a transport case.

The most important applications
- Training in electrochemistry (student internships, demonstration experiments)
- Electrochemical research and development (sensor development, reversibility of electrochemical reactions, reaction kinetics)

PSTAT software
As a result of its intuitive operability, PSTAT software is particularly suitable for training in electrochemistry. Measurement is of the essence. That is why the software includes only those functions that are really important for measurement, i.e. measuring parameters, curves and manual signal evaluation. All of the fundamental electrochemical measurement techniques are available: Cyclic Voltammetry (CV) for investigating the mechanism and kinetics of electrode reactions or for characterizing modified sensors; Differential Pulse Voltammetry (DP) and Square Wave Voltammetry (SWV) for quantitative determination of electrochemically active substances such as mercury, organic substances or cadmium and lead after modification. Chronoamperometric Detection (AD) for demonstrating the functional principle of an amperometric biosensor such as a glucose sensor.

Screen-printed electrodes (SPE)
Inexpensive disposable thick film electrodes make electrochemistry easy. The electrode is inserted into the holder and measurement can begin without further preparation. Each sensor contains the 3 required electrodes: the working electrode, made of carbon, gold or platinum, a silver reference electrode and a carbon auxiliary electrode on a ceramic holder.

Monograph „Electrochemistry – A workbook for 910 PSTAT mini”
The monograph provides an easy introduction to the field of electrochemistry. The book in its handy format includes experiments that describe fundamental phenomena of electrochemical analytics. These experiments can be readily carried out with the 910 PSTAT mini and the electrodes supplied.

Ordering Information
2.910.0010 910 PSTAT mini