THE STRIPPING VOLTAMMETRIC DETERMINATION OF METAL IONS AT SILVER ELECTRODES FABRICATED FROM COMPACT DISCS

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Outline of Talk

• Construction of a silver working electrode from a compact disc
• Cyclic voltammetric behaviour of Pb
• Development of a differential pulse voltammetric method for the determination of Pb
• Determination of Pb in an environmental water sample
Electrode construction

(a)
- Printable layer for label/design
- Ag reflective layer
- Dye data storage layer
- Polycarbonate substrate

(b)
- Substrate
- Ag layer
- Dielectric
- 5 mm diameter hole in dielectric layer
- Ag connection pad
- Ag working electrode
Scanning electron micrograph of the Ag CD surface.

Cyclic voltammetric behaviour of Pb
Underpotentail deposition

Where up to a monolayer of metal is deposited on a foreign electrode substrate at potentials substantially more positive than required for the deposition of the bulk over potential deposition (OPD) of the metal.

\[ \text{Pb}^{2+} + 2e^- \rightleftharpoons \text{Pb} \]

Typical cyclic voltammograms obtained with an ACD in 0.1 M HCl containing 0.1 mM Pb.

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UPD offers a number of advantages:

- At low analyte concentrations metallic deposit covers small percentage of electrode surface hence electrode surface structure remains mainly unchanged improving precision.

- This effect also diminishes the need to clean and reactivate the electrode after measurement.

- The low number of atoms on the electrode surface required means that plating times can be kept short leading to short analysis times.
Differential Pulse Stripping Voltammetry
Effect of deposition potential on the peak current for a 0.1 mM Pb(II) in 0.1 M HCl solution at a ACD. Deposition time 45 s, plus 15 s quiescent.

Effect of deposition time from 10 s to 200 s for a 105 ng/mL Pb solution. Applied potential -0.5 V.

Environmental water sample

The sample = 99.6 ng/mL Pb (%CV = 2.7 %, n = 5).

The sample was fortified with a 100 ng/mL Pb.

Percentage recovery of 95.1 %, (%CV = 5 %).

DPASVs of roof drainage rainwater sample, fortified with 100 ng/mL Pb, with added concentrations of Pb: 0 ng/mL, 22.2 ng/mL, 66.6 ng/mL and 111 ng/mL. Accumulation time: 100 s, deposition potential: -0.5 V (vs. SCE).

Conclusions

• A simple and economic method has been shown for the fabrication of silver electrodes from compact discs.

• Cyclic voltammetric investigations were undertaken to explore the UPD and OPD behaviour of Pb at these electrodes.

• It was possible to utilise the UPD of Pb to determine trace Pb(II) concentrations in environmental water samples by DPASV.

• It is envisaged that further work will be performed to develop ACDs for trace detection of other metal pollutants.
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Thank you for your attention

Reference