



Research Article

# Electrochemical Effect of Ascorbic Acid on Redox Current Peaks of $\text{CoCl}_2$ in Blood Medium

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## Abstract

Cyclic voltammetric technique using glassy carbon electrode of cobalt chloride  $\text{Co(II)}$  was studied in blood medium for the effect of ascorbic acid as an electrocatalyst reagent on the oxidation reduction current peaks of  $\text{Co(II)}$ . It was found that the two oxidation reduction current peaks for  $\text{Co(II)}$  in 0.1M KCl as electrolyte were at 900 and 250 mV respectively. In the study of  $\text{Co(II)}$  in blood medium the result was different, in that the reduction current peak disappeared and the oxidation current peak shifted to a higher potential at 1.4 V. The other study for the effects of different concentrations of ascorbic acid on the anodic current peak of  $\text{Co(II)}$  in blood medium showed an enhancement of the oxidation current peak about three times and the ascorbic acid acted as an electrocatalyst in blood components which caused damage to blood cells.

**Keywords:**  $\text{Co(II)}$ ; Cyclic voltammetry; Blood medium; GCE

## Introduction

Human beings need cobalt compounds in small amounts, but cobalt is toxic in large quantities. It can cause skin irritation when touched. The human body needs small amounts of cobalt for certain vitamins. Cobalt compounds are used to stop cyanide from poisoning the body [1-3]. Many scientists in the early time studied the electrochemical properties of pollutants in blood medium by the cyclic voltammetric technique [4-8].

The study of the kinetics of cobalt electro winning

and the mechanism of the involved reactions have been carried out. The obtained results confirmed the mechanism of cobalt precipitation by depletion of hydroxides. The effects of temperature and scan rate parameters were studied on electro-winning of cobalt by cyclic voltammetry technique. The diffusion coefficient and the rate constant of the reactions were measured and calculated by performed experiments [9].

The cyclic voltammetric (CV) behavior of tris(1, O-phenanthroline)cobalt(III), Cohen) in an aqueous medium which upon the addition of DNA can be used to probe the interaction between these species.

Coordination complexes of 1, IO-phenanthroline and 4,7-diphenyl-1,10-phenanthroline with Ru(II) and Co(III) and other metal chelates<sup>3</sup> that intercalate between the stacked base pairs of native DNA have been actively investigated as probes of DNA structure in solution and as stereo selective or conformation-specific agents for the photo activated cleavage of DNA [10].

Pencil-based renewable carbon paste electrode modified with Zn/Al-2(3-chlorophenoxy)propionate (Zn/Al-CPPA) nanocomposite was developed for the voltammetric determination of cobalt(II). The best voltammetric response was achieved for an electrode composition of 7.5% Zn/Al-CPPA nanocomposite in the paste, 0.1 M sodium acetate of pH 8.0 and the scan rate at  $100 \text{ mVs}^{-1}$  in the voltammetric measurement. Under optimized conditions, a linear response to cobalt(II) was found in the ranges of  $1 \times 10^{-3} \text{ M} - 1 \times 10^{-8} \text{ M}$  and detection limit of  $1.26 \times 10^{-8} \text{ M}$ . High sensitivity and reproducibility were found for the voltammetric determination of cobalt(II) [11].

Cobalt hydroxides were studied on parent substrates with different structural properties: nano-fibre structure, magnetron-sputtered and mechanically treated. The nano-fibred structure was formed electrochemically from an alkaline plating solution. Hydroxide layers were formed on the substrates by anodic polarization. The charge capacity for the nano-fibre sample was found to be up to 5 times higher as compared to a conventional cobalt surface (mechanically abraded). Cyclic voltammetry showed that the electrochemical charge transfer reactions  $\text{Co(II)} \leftrightarrow \text{Co(III)} \leftrightarrow \text{Co(IV)}$  were not associated with a remarkable electrode mass change [12].

The reaction of divalent cobalt(II) and trivalent ruthenium(III) salts ( $\text{NO}_3$ ,  $\text{SCN}$  and  $\text{SO}_4$ ) with macrocyclic ligands L1, L2 and L3 with N<sub>2</sub>S<sub>2</sub>, N<sub>4</sub> and N<sub>5</sub> cores, have been designed and carried out. All these three macrocyclic ligands and their complexes were obtained in the pure form. Electrochemical studies showed that the macrocyclic ligand L1 was more effective electron donors to ruthenium than L2 and L3. Electronic spectral properties also showed that the sulphur donor atom of L1 weakened the ligand field with respect to ligand-to-metal charge-transfer band. [13-17].

In this work, Co(II) ion was studied by electrochemical analysis using voltammetric technique to find the properties of redox current peaks of cobalt

compounds in blood medium in the presence of AA (ascorbic acid).

## Experimental

### Reagents and chemicals

Blood samples were extracted from healthy humans. Cobalt chloride  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  was bought from Seelze Hannover, Germany; AA was bought from Technicon chemicals Co. (Oreg. Tournai Belgique); KCl was bought from SCRC, China. Other chemicals and solvents were of annular grade and used as received from the manufacturers. Double distilled water was used for the preparation of aqueous solutions. All solutions were deaerated with oxygen free nitrogen gas for 15 min prior to performing the measurement.

### Apparatus and procedures

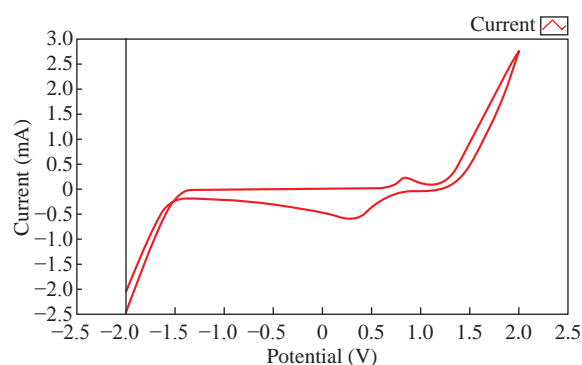
#### Instruments

EZstat series (potentiostat/glvanoostat) of NuVant Systems Inc., USA were used. Electrochemical workstations of bioanalytical system with potentiostat driven by electroanalytical measuring softwares were connected to personal computer to perform Cyclic Voltammetry (CV). An Ag/AgCl (3 M NaCl) and platinum wire (1 mm diameter) was used as a reference and a counter electrode respectively. The glassy carbon working electrode (GCE) was used in this study.

## Results and Discussion

### Identification of redox current peaks of Co(II) in aqueous solution

Fig. 1 shows the cyclic voltammogram of  $\text{CoCl}_2$  in electrolyte solution (0.1 M KCl). The electrochemical properties of cobalt ions in the aqueous solution had

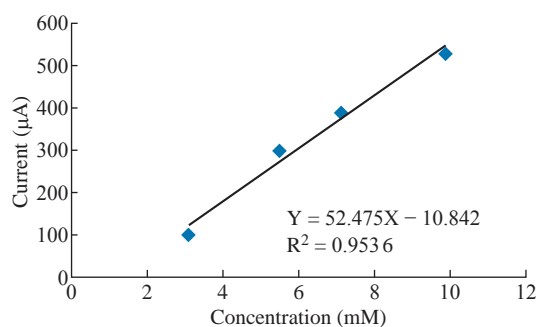


**Fig. 1** The cyclic voltammogram of Co(II) in 0.1 M KCl using GCE, at  $100 \text{ mV sec}^{-1}$  versus Ag/AgCl.

one oxidation current peak at 1 V and one reduction current peak at 0.3 V. Cobalt ions acted as an oxidative reagent in an electrolyte.

### Calibration graph of Co(II) for anodic current peak in aqueous solution

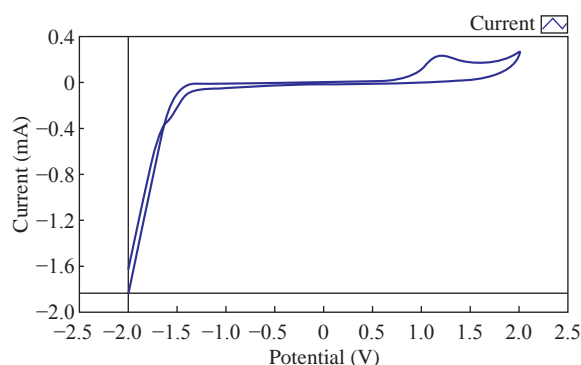
It was found that with increasing the concentration of Co(II) in KCl as an electrolyte, the anodic current peak of Co(II) increased as well. as shown in Fig. 2. The figure shows a good linearity of the relationship between the current and the concentration of cobalt ions as in  $Y = 52.475X - 10.842$  with good sensitivity,  $R^2 = 0.9536$ . The increasing of the concentration of active ions caused the enhancement of current values. The behavior of the cobalt ion in the electrolyte was among the expected good results.



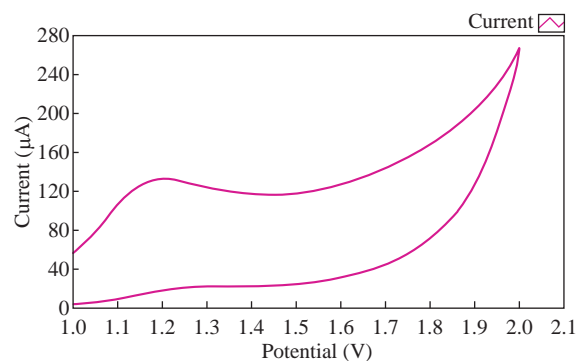
**Fig. 2** The plot anodic current peak of Co(II) against different concentrations of Co(II) in 0.1 M KCl solution.

### Effect of blood medium on redox current peaks of Co(II)

Fig. 3 & 4 show the effect of normal human blood medium as an electrolyte on the redox current peaks of cobalt ions. It was found that the reduction current peak of Co(II) in blood medium totally disappeared and the oxidation current peak enhanced about three times. Cobalt ions acted as an oxidative reagent in



**Fig. 3** The cyclic voltammogram of Co(II) in blood medium using GCE, at  $100 \text{ mV sec}^{-1}$  versus Ag/AgCl.

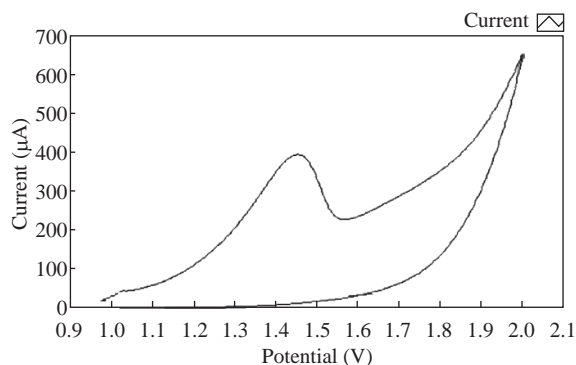


**Fig. 4** The voltammogram of the anodic current peak of Co(II) in blood medium using GCE, at  $100 \text{ mV sec}^{-1}$  versus Ag/AgCl.

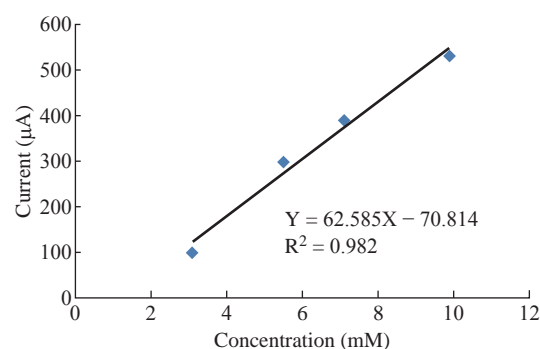
blood medium and the high concentration caused the decomposition of blood components. The trace of cobalt ion as a tonic medicine for human body was of enough amount; higher amounts would cause the bad state in blood decomposition by oxidation in the blood.

### Effect of AA on the redox current peaks of Co(II) in blood medium

In blood medium cobalt ions with the presence of AA as an antioxidative reagent enhanced the oxidation current peak of Co(II) and shifted to a higher potential as shown in Fig. 5. But the new phenomena appeared



**Fig. 5** The voltammogram of anodic current peak of Co(II) in blood medium with AA using GCE, at  $100 \text{ mV sec}^{-1}$  versus Ag/AgCl.



**Fig. 6** The plot oxidation current peak of  $\text{CoCl}_2$  against the concentration of AA.

when increasing the concentration of AA which decreased the oxidation current peak of Co(II) as shown in Fig. 6. When plotting the oxidation current peak of Co(II) against the concentration of ascorbic acid, the linear relationship was  $Y = 62.585X - 70.814$  with a good sensitivity,  $R^2 = 0.982$ . AA acted as a good inhibitor for the effect of cobalt ions in blood medium.

## Conclusions

The electrochemical study of cobalt ions in the presence of important interference with AA using GCE in blood medium was reported by cyclic voltammetric technique. It was found that the redox current peaks of Co(II) in aqueous electrolyte (0.1 M KCl) as an oxidative and antioxidative metal in aqueous electrolyte. But in blood medium, the Co(II) ions had an oxidative behavior by reducing the reduction current peak. Also, it was found that AA acted as an electrocatalyst by enhancing the oxidative current peak in blood medium. Hence, the cobalt ion in blood medium acted as an oxidative agent and with AA acted as an inhibitor factor in blood medium.

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