

## Research Article

# Electrochemical Deposition and Dissolution of Thallium from Sulfate Solutions

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The electrochemical behavior of thallium was studied on glassy carbon electrodes in sulfate solutions. Cyclic voltammetry was used to study the kinetics of the electrode processes and to determine the nature of the limiting step of the cathodic reduction of thallium ions. According to the dependence of current on stirring rate and scan rate, this process is diffusion limited. Chronocoulometry showed that the electrodeposition can be performed with a current efficiency of up to 96% in the absence of oxygen.

## 1. Introduction

The development of new branches of science and technology dramatically increases the demand for nonferrous metals used in various industries. Today it is difficult to find a technical field in which nonferrous metals, their alloys, and compound do not play an important role. In particular, thallium is used for production of bearing and fusible alloys, semiconductors, as a source of  $\beta$ -radiation in the radioisotope devices. It is known that alloys containing thallium have high wear resistance, inertness to acids, and fusibility [1–3]. The high toxicity and volatility of thallium compounds are not fundamental obstacles to its use [4–6]. Metals like Ga, In, and Tl are mainly distributed in the form of isomorphous impurity in minerals of other elements, with which they are extracted simultaneously and later separated. For the latter, the development of environmental friendly technologies, especially electrochemical processes, is of great importance. In order to develop a technology for the electrolytic separation and refining of thallium it is necessary to study its electrochemical behavior in different electrolytes, in order to establish the influence of the nature of

electrolytes, electrolysis conditions, and so forth, on the cathodic electrodeposition and anodic dissolution of that metal. The anodic polarization curves using smooth rotating polycrystalline thallium electrode have been investigated in alkali, sulfate and acetate solutions with different ionic strengths (0.01–1.2) and pH (0.5–13.8), and using  $Tl_2SO_4$  concentrations in the range of 0.1–10  $mmol L^{-1}$  [7]. The electrochemical dissolution of thallium from the surface of a mercury film electrode has been also studied in different supporting electrolytes [8]. The authors have considered the effects of the thallium concentration, of deposition potential and deposition time and of the potential sweep rate. The deposition of thallium has also been investigated using n-Si electrodes [9]. With the help of an electrochemical quartz microbalance and voltammetry it has been shown [10] that thallium(I) ions adsorbed on a positively charged thin film mercury electrode, probably in the form of ion pairs, are not undergoing a reduction. At the potentials where adsorption was observed, only dissolved thallium(I) ions were reduced directly from the solution. Results of the study of the electrochemical behavior of thallium in a solution of 0.25  $mol L^{-1}$  solution of hydrochloric acid on gallium and