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THE USE OF ELECTROCHEMICAL ANALYSIS METHODS IN STUDYING THE TOPIC OF ALLOYS IN THE CHEMISTRY CIRRICULUM FOR THE TRAINING SYSTEM OF MILITARY SPECIALISTS

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ABSTRACT	KEYWORDS
The kinetics of anodic dissolutions of gold-silver alloys containing up to 20 wt. % silver in hydrochloric acid solutions of varying concentrations was investigated using the electrochemical method of polarization curves. It was demonstrated that the dependence of current on time can be consistently described by models of the formation and thickening of a porous silver chloride film, taking into account the partial current of silver and its dependence on the alloy composition.	alloys, solid solutions, anode, cathode, anodic dissolution, potentiostatic methods, passivation, chloride solutions, refining, electrolytic cell, membrane, current density, potential.

Introduction

Lead scrap from battery production, refining scrap from jewelry plants, alloys for dental prostheses, special solders, etc. are potential sources for increasing the production of non-ferrous and precious metals in the Republic of Uzbekistan.

Anodic dissolution of gold-silver alloys in hydrochloric acid solutions by electrochemical methods is widely used in the refining technology of noble metals using the Wohlwill process [1]. One of the most strictly controlled impurities in anodes is silver (its content should not exceed 12% by weight), as during dissolution it forms a layer of insoluble silver chloride on the anode, which complicates the refining process. However, in recent years, the share of alloys (e.g., jewelry, dental, and special alloys) with a higher silver content in the raw materials for processing has been increasing. Therefore, studying the features of electrochemical dissolution of such alloys is a relevant and important task.

Research Methods

Gold-silver alloys (containing 4 to 20 wt% silver) in the form of cylinders with a diameter of approximately 1 mm were prepared from weighed amounts of high-purity gold and silver (99.99%) by melting under vacuum in a special graphite container, followed by holding the melt for 3–5 hours. The obtained samples were embedded in a Teflon casing and used in a standard device for the mechanical renewal of microelectrode surfaces [2]. Anodic polarization curves and current decay curves at a given overpotential were recorded using a PA-3 polarograph.

Discussion of Results

On the anodic polarization curve of pure gold in chloride solutions (Fig. 1, curve 1), in the overpotential range of **η = 300–600 mV**, a steady-state region of active dissolution is observed with a well-defined limiting current. The magnitude of this current is proportional to the chloride concentration [3] and to the square root of the potential scan rate, indicating that it is a diffusion-limited current governed by Cl^- anions.

With further anodic polarization, the surface of gold becomes passivated due to the formation of an oxide film, followed by the evolution of chlorine gas.

In contrast to pure gold, the anodic dissolution of gold-silver alloys (Fig. 1, curves 2–5) does not exhibit a steady-state region of active dissolution. At all overpotentials, gradual passivation of the anode occurs over time due to the formation of a silver chloride film. It is also evident that the passivation effects become more pronounced as the silver content in the alloy increases.

Under potentiostatic conditions, the anodic current decreases over time. Its initial value and the rate of decay depend on the overpotential (Fig. 2), the chloride ion concentration in the solution, and the silver content in the alloy. As the overpotential increases, both the initial current and the decay rate increase. However, starting from **η = 400–450 mV**, the i–t transients at different values of η practically converge, likely indicating a transition to a diffusion-controlled dissolution regime of the predominant alloy component.

Quantitative regularities of anodic film growth on metals (including the shape of i–t curves) have been studied in several works, but only for pure metals [4]. In the present study, it is additionally necessary to consider that although the anodic current contributes to the dissolution of both components, the passivating layer of the insoluble compound is formed by only one of them.

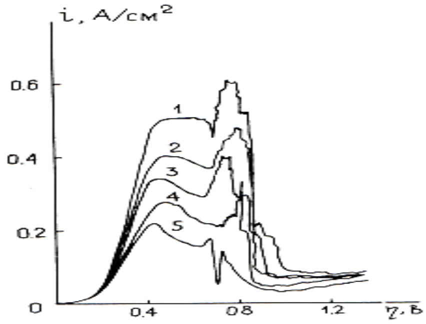

Fig. 1. Anodic polarization curves for the dissolution of pure gold (1) and gold-silver alloys with silver content, wt%: 4 (2), (3), 16 (4), 20 (5).

Solution composition: *0.5 M HCl + 1.5 M NaCl,*
Potential scan rate: *2 mV/s,*
Temperature: *25 °C.*

The aim of the study was to investigate the time-dependent process of anodic dissolution of a binary alloy, in which one component forms a highly soluble, and the other — an insoluble compound with the electrolyte anion [5].

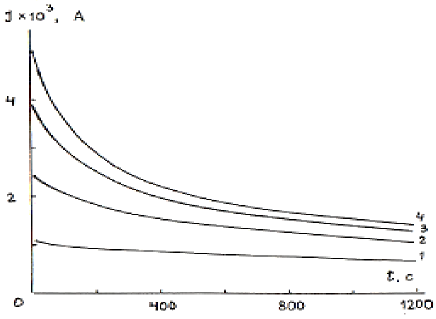

Fig. 2. Potentiostatic anodic dissolution curves for an alloy containing 4 wt% silver at η = 500 mV in solutions with different total chloride concentrations (adjusted by NaCl addition, mol/L): 1 – 0.5; 2 – 1.0; 3 – 2.0; 4 – 3.0.

Based on general physical considerations, at least two distinct regions can be expected on the i–t curve.

The first region reflects the dynamics of the formation of a continuous AgCl film from individual islands at a constant layer thickness, while the second corresponds to the thickening dynamics of the already formed layer [5].

Conclusion

The kinetics of anodic dissolution of gold-silver alloys in chloride solutions can be satisfactorily described by existing models of continuous silver chloride film formation and its subsequent thickening, provided that these models take into account the partial current for silver instead of the total current density, as well as its dependence on the alloy composition.

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References

1. Wohlwill E. Uber Goldsheidung auf Elektrochemischen Wege // Z. Elektrochimie. - 1898. - N 4. - S. 379-423.
2. Бек Р.Ю., Лаврова Т.А. Исследование кинетики электроосаждения золота и серебра из тиомочевинные и роданистых электролитов // Изв. СО АН СССР. Сер.хим.наук. - 1971. - № 4.- Вып. 2. - С.17-20.
3. Frankenthal R.P., Thompson D.E. The Anodic Behavior of Gold in Sulfiric Acid Solutions. Effect of chloride and Electrode potential // J. Electrochem. Soc. -1976.-V.123, N 6.-P. 799-803.
4. Muller H.J. Die Bedeckungsteorie der Passivitat der Metalle. - Berlin; Verlag Chemie, 1933.
5. Маслий А.И., Медведев А.Ж., Зиядуллаев А.Ш., Абдураимов Е.Е. Влияние концентрации серебра на кинетику пассивации анодов из золотосеребряных сплавов в хлоридных растворах // Сибир. хим. журнал, 1991. Вып. 6. С. 110-114.