

**COORDINATION COMPOUNDS OF SILVER WITH 2
[PHENYLMETHYL]-1H-BENZIMIDAZOLE**

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**КООРДИНАЦИОННЫЙ СОЕДИНЕНИЙ СЕРЕБРА С 2-
[ФЕНИЛМЕТИЛ]-1Н-БЕНЗИМИДАЗОЛОМ**

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ANNOTATION

Coordination compounds of intermediate metals are increasingly used in various fields of science and technology. The study of complexing with new classes of organic ligands opens up broad prospects for their application in metallurgy, chemical industry, medicine and agriculture. The rapid development of coordination chemistry is directly related to the study of the role of metal complexes in vital processes. The study of the mechanism of action of physiologically active substances on biological membranes, enzymes, etc. is one of the current issues. Although coordination compounds of intermediate metals with 2- [phenylmethyl] -1H-benzimidazole derivatives have been considered in many studies, at the beginning of our study there were no data on mixed-ligand coordination compounds of silver containing benzimidazole derivatives. Around the central atom, benzimidazole as the main ligand and diethyldithiocarbamate as the mixed ligand complex compounds have not been synthesized and the reasons for the competitive coordination of the ligands have not been shown.

АННОТАЦИЯ

Координационные соединения промежуточных металлов находят все более широкое применение в различных областях науки и техники. Изучение комплексообразования с новыми классами органических лигандов открывает широкие перспективы их применения в металлургии, химической промышленности, медицине и сельском хозяйстве. Бурное развитие координационной химии непосредственно связано с изучением роли металлокомплексов в процессах жизнедеятельности. Изучение механизма действия физиологически активных веществ на биологические мембраны, ферменты и др. является одной из актуальных проблем. Хотя координационные соединения промежуточных металлов с производными 2-[фенилметил]-1H-бензимидазола рассматривались во многих работах, в начале нашего исследования не было данных о разнолигандных



координационных соединениях серебра, содержащих производные бензимидазола. Вокруг центрального атома бензимидазол как основной лиганд и диэтилдитиокарбамат как разнолигандные комплексные соединения не синтезированы и причины конкурентной координации лигандов не показаны.

Key words: Silver ion, 2- [phenylmethyl] -1H-benzimidazole (FAB), diethyldithiocarbamate (DEDTK), IR-Fure (IR), element analysis, X-ray phase (RFA), energy-dispersion analysis and scanning electron microscopy (SEM-EDX) were used as research methods.

Ключевые слова: Ионы серебра, 2-[фенилметил]-1H-бензимидазол (FAB), диэтилдитиокарбамат (DEDTK), IR-Фуре (IR), элементный анализ, энергодисперсионный анализ и сканирующая электронная микроскопия (SEM- EDX) использовались в качестве методов исследования.

Introduction

The chemistry of coordination compounds containing metal-nitrogen and metal-sulfur bonds is attracting more attention [1]. Synthesis of films and bulk samples of metal sulfides from complex compounds with sulfur-containing ligands having M-S fragments in the molecule is currently an important direction of electronic materials science [2]. Internal complex compounds of metals with sulfur-containing ligands are of particular interest, because there are a lot of volatile substances among them. Such compounds include metal diradicaldithiophosphates and diradicaldithiophosphinates [3].

Diradicaldithiophosphoric acid $(RO)_2PS_2H$ and diradicaldithiophosphinate R_2PS_2H anions interact with metal ions and form internal complex compounds. O,O'-diradicaldithiophosphoric acids and their complex compounds are used in analytical chemistry, extraction [3]. The use of dithioacids containing phosphorus and sulfur atoms is due to the high stability of complex compounds formed by them with many metal ions in a wide pH range. Di(2-ethylhexyl)dithiophosphoric acid can be used to extract cobalt and nickel [4]. Coordination compounds with $(RO)_2PS_2^-$ и $R_2PS_2^-$ ions are of practical interest as vulcanization accelerators, additives to lubricating oils and motor fuels, catalysts [5]. Biological activity has been found for some diradicalthiophosphates of transition metals (Ni(II), Pd(II), Pt(II)) [6,7]. Metals that interact with diradicaldithiophosphate and diradicaldithiophosphinate ions include



Cu, Fe, Co, Ni, Zn, Cd, and Ag. The interest in Cu, Cd, Co is due to the fact that they are all part of many biosystems and belong to typical "biometals" [8]. Nickel's participation in biochemical processes was discovered relatively recently, and it has aroused great interest. In biochemical systems, Ni²⁺ ions coordinate donor atoms (O, N, S) of various organic substances. Ni(II) stabilizes the structure of RNA and DNA, activates several enzyme systems (arginase, carboxylase, trypsin, etc.) [9]. Many scientific researches have been carried out on the synthesis, structure and properties of dialkylditophosphoric acids and their complexes with d-metals. Also, the current state of research on the synthesis of mixed ligand coordination compounds of dialkyldithiophosphate complexes of transition metals with nitrogen heterocyclic compounds, the fields of studying and applying their composition by modern physicochemical methods are analyzed.

The analysis of the trends available in the sources in the literature shows that this direction remains relevant due to the lack of synthesis of mono- and mixed-ligand coordination compounds of silver containing FAB. Also, the lack of or very little information about the structures of such complex compounds, the nature of coordination of metal ions in them became the basis for conducting scientific work on this topic. The aim of the work is to synthesize new coordination compounds of the silver ion monozygotazole and mixed ligand stored by benzimidazole, to study their structure and properties by establishing interrelationships between composition, structure, properties. Objectives of the work are to create conditions for the synthesis of mono- and mixed ligand-based coordination compounds of silver ions on the basis of benzimidazole, to determine the composition of the obtained complexes, structural properties, the nature of chemical bonds and the relationship between "composition-structure-properties". study the properties of the structure.

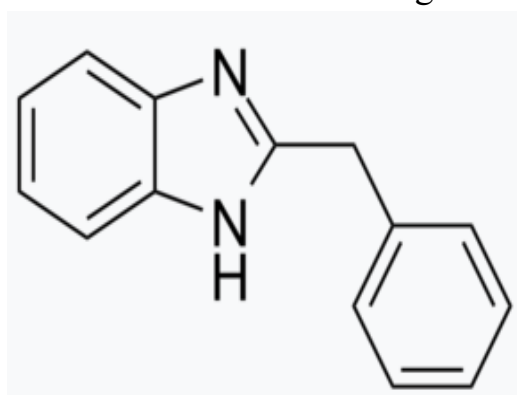
Methods and materials

The following "pure" and "chemically pure" reagents were used in the thesis work: sulfur, red phosphorus, ethanol, isopropyl alcohol, acetone, chloroform, AgNO₃. A solution of a metal salt was prepared by dissolving a specific sample in a certain amount of water and acid. Nitrogen heterocycle 2- [phenylmethyl] -1H-benzimidazole (FAB), [10] was synthesized according to the methodology described in the literature. Distilled water, ethanol, chloroform, diethylether, hexane, acetone were used as solvents. Analysis of the metal content of coordination compounds was carried out by the atomic absorption method in the RE 30-30B spectrophotometer. Analysis for S, N, S was performed on a Carlo-Erba EA-1108

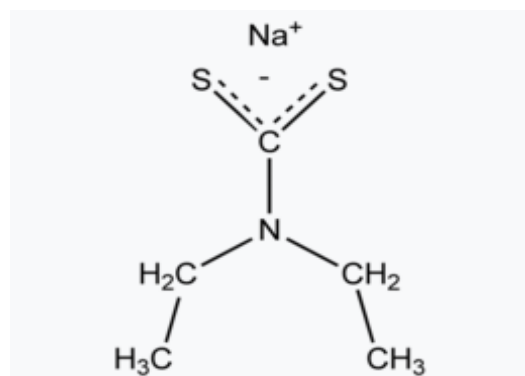


elemental analyzer. A high-efficiency energy-dispersive X-ray fluorescence spectrometer (Japan, Rigaku NEX CG EDXRF) was also used for elemental analysis.

A LabX XRD-6100 diffractometer (Shimadzu, Japan) with CuK α -radiation was used to determine the individuality of the synthesized complex compounds. The table [89-90] was used to calculate interplane distances. Scanning was performed at the maximum power of the X-ray generator with a scanning step of 0.05 (2 θ) $^\circ$ in the range of 15-90 $^\circ$ (2 θ) angles. The resulting phase determinations and quantitative calculations were performed using the ICDD (PDF-2) X-ray data file. The structures of the main ligand MAB and the additional ligands is as follows:



FAB



DEDTK

Synthesis of mono- and mixed-ligand complex compounds

[Ag(FAB)₂(DEDTK)]. A solution of 0.71 g (0.001 mol) of DEDTK in 10 ml of water was added while stirring to a 5 ml aqueous solution of 0.170 g (0.001 mol) of AgNO₃. The reaction mixture was stirred at room temperature on a magnetic stirrer for one hour. Then, a solution of 0.416 g (0.002 mol) of FAV in 10 ml of ethanol was added dropwise with stirring. The mixture was heated on a water bath for one hour in a reflux-refrigerated flask. After cooling, it was filtered, washed with water and alcohol.

The dried cream-colored precipitate was refiltered in boiling absolute alcohol. White-cream needle-like crystals were formed. The yield is 77%.

Calculated: Ag -15.39, C-57.14, H-4.61, N-10.10, S-4.61

Found: Ag- 15.17, C-56.5, H-4.25, N-9.85, S-4.33



All synthesized complex compounds are insoluble in water, low in alcohol, well soluble in benzene, acetone, ether, carbon tetrachloride, chloroform.

Results and Discussion

The scanning SEM-EDX is now widely used to determine of the nitrogen, sulfur and metal amounts in the prepared complex compounds (Figure 1). The silver peaks is clearly seen due to complex formation between the organic ligands and metal ions. The microstructure of the ligands was changed.

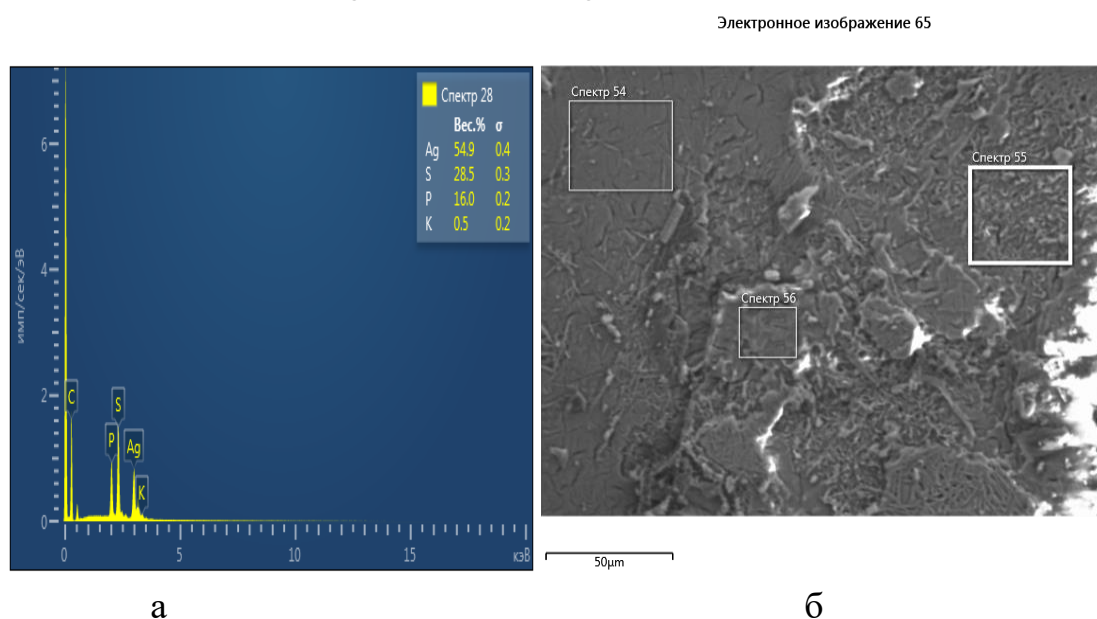


Figure 1. Microstructure of [Ag (FAB)₂(DEDTK)] complex compound (a) and SEM-EDX data (b)

XRD of the synthesized complexes shows that samples do not contain impurities of the original products. The presence of many XRD intense peaks indicates the complex crystalline structure of the complexes. It was found that XRD patterns, plane d-spacing and line intensity of metal complexes differed from the corresponding ligands. This indicates that the synthesized complex compounds have a separate individual crystal lattice.

Conclusion

Favorable conditions for the synthesis of mono- and mixed-ligand complex compounds of silver FABs have been identified, which may serve as a basis for practical recommendations for targeted synthesis of related coordination compounds;



The results of quantum chemical analysis of the chemical ability of ligands and data on spectral determination of the structure of ligands and complexes can be used as reference materials;

Among the interdependence of physicochemical properties of new complexes, specificity (type of compound, central ionic nature, coordination of neutral and heterocyclic ligands) was noted and the conditions for the synthesis of bioactive compounds were determined;

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