

# SYNTHESIS OF A SILICON-CONTAINING COMPOUND CONTAINING SODIUM METALSILICATE AND IR- SPECTROSCOPIC ANALYSIS OF THE OBTAINED PRODUCT

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**Abstract.** In this article, a compound containing silicon was synthesized based on urea and sodium metasilicate, and the initial reagents and the obtained products were analyzed using the IR-spectroscopy method. As a result, it was proved that different proportions of the initial reagents affect the number of amino groups in the obtained product. It was observed that changing the ratio of the initial reagents leads to a change in the absorption peaks in different areas that appear in the IR spectrum of the obtained products.

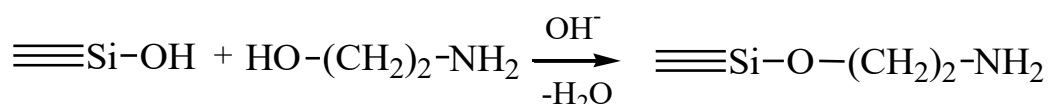
**Keywords:** silicon, nanohybrid, sorbent, hydrometallurgy, sorption capacity, sorption-desorption, wastewater, silver.

## Introduction

All known sorbents containing silicon are divided into two main categories. The first natural and synthetic mineral carriers based on silicon dioxide and chemically modified products. The physicochemical properties and application of these materials are presented in many scientific works [1].

## Literature analysis and methods

Currently, in many research studies, great importance is attached to obtaining selective sorbents by the method of chemical modification of silica gel [2]. In particular, in [3], the synthesis of complex-forming sorbents by modifying orthosilicic acid with mono- and diethanolamines is presented as follows:



The possibility of extracting  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$ ,  $^{90}\text{Y}$  isotopes, and ions of d-elements such as  $\text{Cu}^{2+}$ , and  $\text{Ni}^{2+}$  from aqueous solutions was investigated in the work using large porous sorbents containing triethylenediamine.

## Results and discussions

Selective sorption of phosphate arsenate and silicate anion compounds from aqueous solutions of ammonium molybdate and tungsten was studied using a composite sorbent consisting of cationic KU-23 (or KM-2p) and citrated zirconium oxide [4]. All minerals and synthetic sorbent materials containing silicon constitute a wide group of compounds with different physical, chemical, and technical properties [5].

The product obtained by condensing melamine with formaldehyde and epichlorohydrin and hardening it with polyethylene polyamine must have the property of separating rhenium and molybdenum ions. The total exchange capacity of the obtained anyone is 4.5-5.2 mg-equiv/g, the relative viscosity is 80-100%, the spreadable weight is 0.7 g/ml, and the total nitrogen content is 20-25% [6].

**Practical part:** For the mutual reaction of urea and sodium metasilicate, initially, the

starting reagents were taken in two different mass ratios (15/85, urea/sodium metasilicate solution), and the process was carried out according to the above method. The area was crushed in a mortar, and the ground urea was mixed with the metasilicate solution using a paddle mixer at a speed of 120 revolutions per minute. The duration of mixing is from 10 to 20 minutes, the duration of mixing depends on the complete dissolution of urea and the formation of a gel. To slow down the process of gel formation and fully dissolve urea in sodium metasilicate solution and to increase its interaction with sodium metasilicate, the reaction mass was kept at a temperature of 40-50 °C and stirred continuously. A catalyst was added to the reaction mass in the amount of 0.2% compared to urea. As a result of the interaction of metasilicate sodium and urea, a gel was formed within 10-20 minutes. The resulting gel was left for one day, and after one day the gel changed to a brittle brittle state, the gel that had reached a brittle state was crushed and processed under special conditions at the above-mentioned temperature. The resulting mass was finely ground, washed well in distilled water, and dried again. The process was carried out in the same way for both compositions, sodium metasilicate solution was used in both compositions at the same concentration. The dried product is in the form of a white powder, and due to its functional groups, it has the property of sorption of heavy and rare metals from solutions of different concentrations and modification of various compositions. The resulting substance and the initial products were compared and analyzed by taking IR spectra.

Urea was used as the starting organic material in the study and it was subjected to IR-spectroscopic analysis. Figure 2.2 shows the IR spectrum of urea.

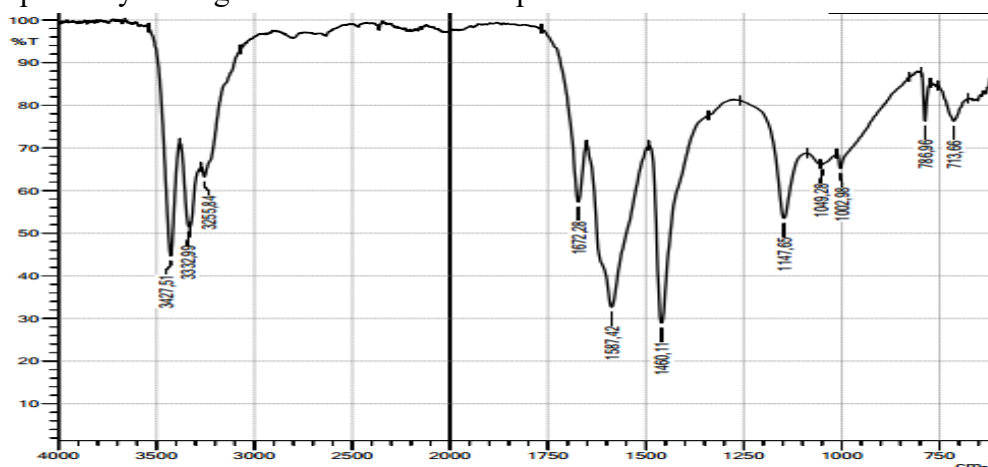
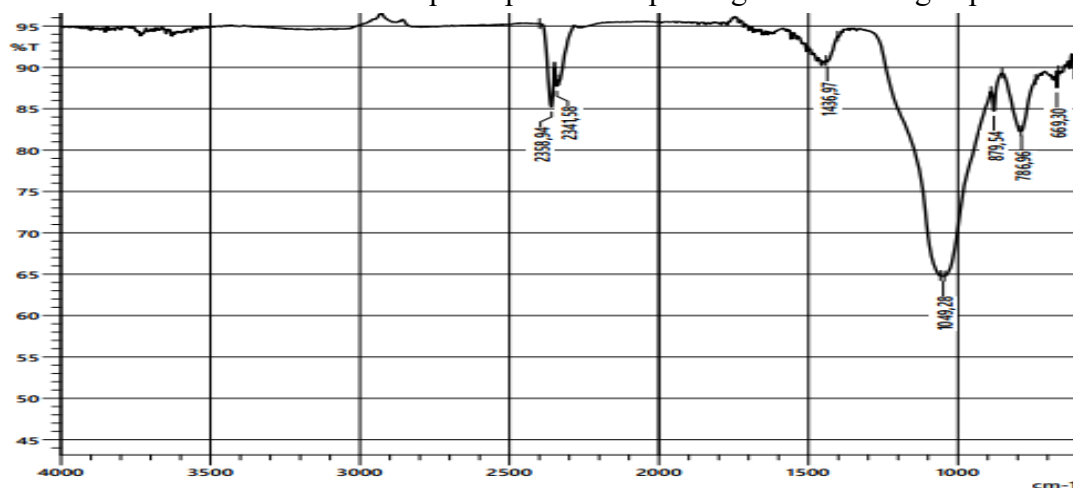


Figure 2.2. IR spectrum of urea

Depending on the presence of absorption bands in the high-frequency part of the IR spectrum (3600-3100  $\text{cm}^{-1}$ ), it can be concluded about the presence or absence of -ON or -NH ( $>\text{NH}$ ) groups in the composition of the molecule. Substances containing -NH<sub>2</sub> or  $>\text{NH}$  are different. However, general similarities between them can be observed. Bands caused by asymmetric and symmetric valence vibrations of the amino group, unlike the bands belonging to the ON group, are often divided into two or three parts (doublet, triplet). As can be seen from the above figure, the absorption peaks at 3427.51  $\text{cm}^{-1}$ , 3332.99  $\text{cm}^{-1}$ , and 3255.84  $\text{cm}^{-1}$  are the bands caused by asymmetric and symmetric valence vibrations of the urea -NH<sub>2</sub> group. In addition, absorption peaks in the region of 1587.42  $\text{cm}^{-1}$  are due to asymmetric deformation of the -NH<sub>2</sub> group, as well as wave absorption in the region of 1147.65  $\text{cm}^{-1}$ , 786.96  $\text{cm}^{-1}$ , 713.66  $\text{cm}^{-1}$ , and these peaks are due to valence vibrations of the -NH<sub>2</sub> group shows. The vibrational frequency of the N-C group appears in the region of 1049.28  $\text{cm}^{-1}$ , while the valence vibration of the C=O group

shows its intense, characteristic peak in the absorption region of  $1672.28\text{ cm}^{-1}$ . The band in the region of  $1460.11\text{ cm}^{-1}$  shows the absorption peak corresponding to the C=O group of carbamide.



**Figure 2.3. IR-spectrum of the product obtained on the basis of sodium urea and metasilicate (15/85).**

The IR-spectrum analysis of the product obtained based on urea and sodium metasilicate was carried out and compared with the IR-spectrum of the original substance, urea. The IR-spectrum of the synthesized product (15/85 urea/metasilicate sodium solution) is shown in Fig. 2.3. According to it, the bands caused by asymmetric and symmetric valence vibrations of the  $\text{-NH}_2$  group in the high-frequency part of the IR spectrum,  $3427.51\text{ cm}^{-1}$ , It can be seen that the triplet absorption peaks at  $3332.99\text{ cm}^{-1}$  and  $3255.84\text{ cm}^{-1}$  have disappeared. At the same time, the main frequency of the valence vibration of the C=O group appeared at about  $1680\text{ cm}^{-1}$ , and the first overtone of this band was observed in the form of a low-intensity band with a frequency of about  $3200\text{ cm}^{-1}$ . Due to the high intensity of the valence vibration belonging to the Si-O-Si group at  $1049.28\text{ cm}^{-1}$ , the absorption peak at  $1049.28\text{ cm}^{-1}$  belonging to the  $\text{-NH}_2$  group with moderate intensity at the same area belonging to urea is not visible. The band in the region of  $1460.11\text{ cm}^{-1}$ , correspondingly, the absorption peak belonging to the C=O group of carbamide manifests itself with low intensity in the region of  $1436.97\text{ cm}^{-1}$ , while the valence wave belonging to the C=O group, as a result of vibrations, has its peak in the absorption region of  $1672.28\text{ cm}^{-1}$  an intense absorption peak appears in approximately this area, but with less intensity. Due to the valence vibrations of the  $\text{-NH}_2$  group, the wave absorption peaks in the  $786.96\text{ cm}^{-1}$  and  $713.66\text{ cm}^{-1}$  areas manifest themselves in these areas without any change. It can be observed that the absorption bands at  $879.54\text{ cm}^{-1}$  corresponding to the C-O group belonging to the oxygen of polysilicate and the carbon of urea are formed.

### Conclusion

In conclusion, it can be seen from the above analysis that the ratio of the initial reagents increases the number of amino groups in the obtained product, as a result of which the specific property of the obtained product, that is, characteristic of amino groups, including the property of complex formation with metal ions in solutions, increases. The selected proportions are highly dependent on the concentration of sodium metasilicate solution used as a starting reagent, and this indicator is the basis for choosing the ratio of starting reagents. The obtained product can be used in various aspects of the industry, in metallurgy, in the production of cement-concrete products, as well as various modifying additives.

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