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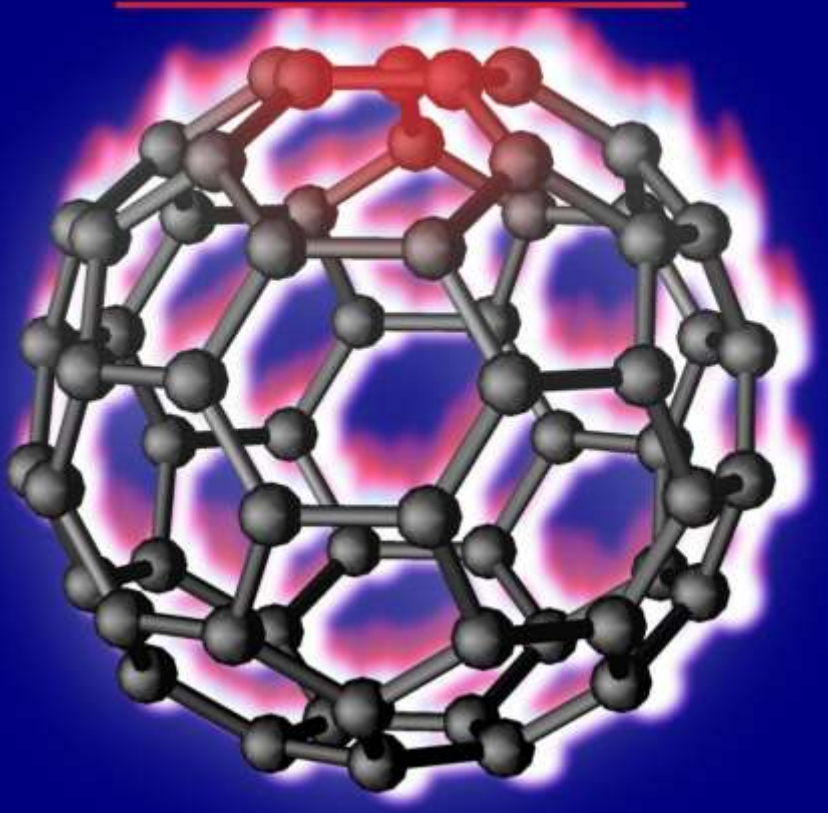
The Physics and Chemistry of Carbon and Nanoenergetic Materials



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ALMATY, KAZAKHSTAN

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APLLICATION OF DIATOMITE FOR ENERGY STORAGE DEVICES

[1,2]Turganbay A.B., [1,2]Zhaparova A., [1,2]Nazhipkyzy M., [1,2]Lesbayev B.T., [1,2]Mansurov Z.A.
[1]Institute of Combustion Problems, 050012, Kazakhstan, Almaty, Str. Bogenbai Batyr, 172
[2]Al - Farabi Kazakh National University, Kazakhstan, Almaty, Ave. al - Farabi, 71
anar.turganbaeva@mail.ru

The ability to produce low-cost, hierarchically-structured and nanopatterned inorganic materials could potentially revolutionize the way we fabricate photovoltaic, energy storage, and optoelectronic devices. In nature, many organisms carry out the hierarchical assembly of metal oxide materials through cellular and biochemical processes that replicate periodic micro- and nanoscale features by a bottom-up approach at ambient conditions. For example, single-celled algae called diatoms produce a nanostructured amorphous silica skeleton called a frustule. The insertion of other metal oxide materials such as titanium or germanium dioxide into the nanostructure of the diatom frustule could potentially be utilized to fabricate new dye-sensitized solar cells, nanostructured battery electrodes, and electroluminescent display devices.

Thus, for the purpose of using diatomite, it was fully investigated. In this work, a comprehensive study of the characteristics of the Kazakhstan diatomite by physicochemical methods was carried out.

1.1 X-ray diffraction analyzes

Figure 1 shows the results of x-ray diffraction analyzes of selected diatomite samples from the Mugalzhar area of the Aktobe region.

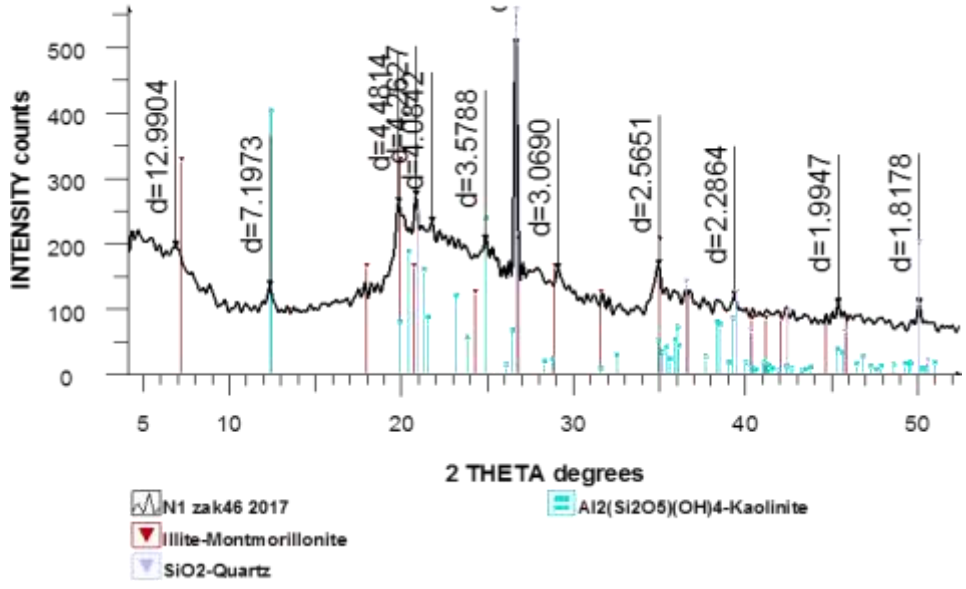

Figure 1 - Resultant X-ray fluorescence analysis of diatomite

As can be seen from Fig. 1, the sampled sample contains a lot of quartz, and the remaining components are crystalline phases containing mainly SiO_2. Note that quartz is a polymorphous modification of silicon dioxide.

The figure shows the constituent components of diatomite: Illit-montmorillonite, Al_2 (Si2O5) $(OH)_{4-}$ Kaolinite are present in a small amount. SiO_2-Quartz is somewhat larger, in addition, a significant amount of X-ray amorphous phase is present.

1.2 X-ray fluorescence analysis (XRF)

1.1. X-ray fluorescence analysis (XRF) At the next stage, X-ray fluorescence analysis (XRF) was used to determine the elemental composition of diatomite. X-ray fluorescence analysis (XRF) is one of the modern spectroscopic methods for studying a substance in order to obtain its elemental composition, that is, its elemental analysis. With the help of it, various elements from beryllium (Be) to uranium (U) can be analyzed.

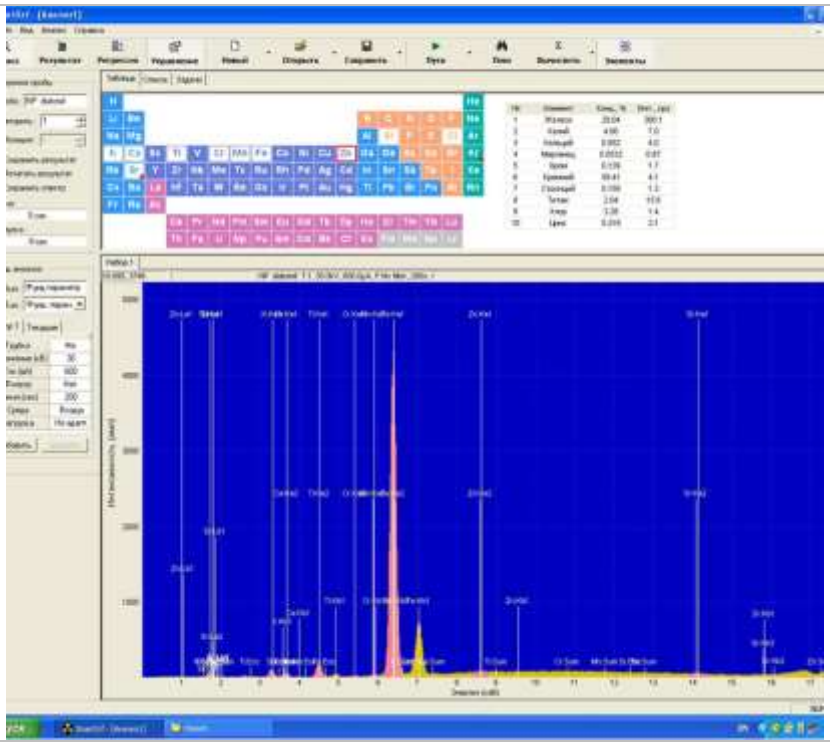

Figure 2 - Result of X-ray fluorescence analysis of diatomite samples

X-ray spectral analysis can be used for quantitative determination of elements in materials of complex chemical composition - in metals and alloys, minerals, glass, ceramics, cements, plastics, abrasives, dust and various products of chemical technologies.

1.3 Method of infrared spectroscopy

The method of infrared spectroscopy is a universal physicochemical method, which is used in the study of the structural features of various organic and inorganic compounds.

The analysis of the IR spectra results is shown in Figure 3. As a result, they were matched with the corresponding XRD data. The peaks found in the bands 3698 and 3621 cm^{-1} of natural

untreated diatomite refer to the OH-vibration regime of the hydroxyl groups of kaolinite. A broad band centered at 3432-36 cm^{-1} was attributed to the OH vibration mode of physically adsorbed H_2O. The peaks associated with Si-OH or Al-OH are at the level of 915-917 cm^{-1} and Si-O-Al and are linked to the Al-octahedral sheet, found at 533 cm^{-1}. The bands were found about 793-798 cm^{-1} bound by free silica and / or quartz and are found in all the starting materials of diatomite.

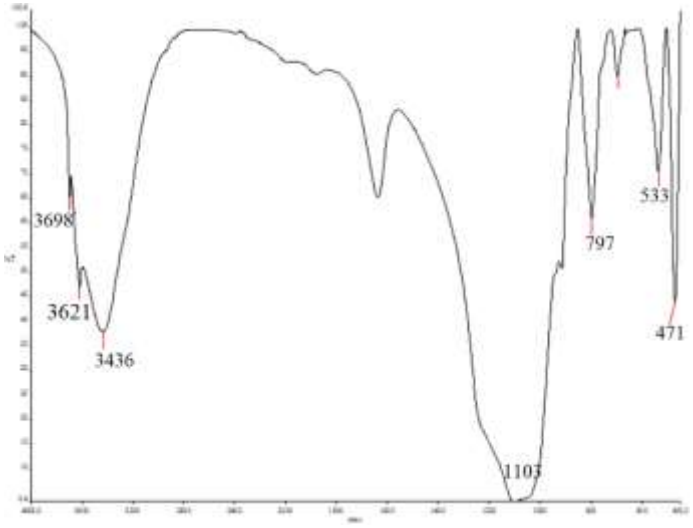

Figure 3 - The transmission spectra of natural diatomite are characterized by absorption bands at 1103, 797, and 471 cm^{-1}, caused by deformation vibrations of the Si-O quartz bond. The absorption bands at 797 cm^{-1}, and especially at 1103 cm^{-1}, associated with deformation vibrations of the CO_3^{2-} group, are due to the presence of calcite in the sample

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According to studies, it can be assumed that this variety of shapes and ordered porous structures of diatomite irrefutably demonstrates the precision and brilliance of natural design on a micro- and nanoscale, providing a great opportunity to use this material for wide application.