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The Institute of Combustion Problems
National Nanotechnology Laboratory of Open Type

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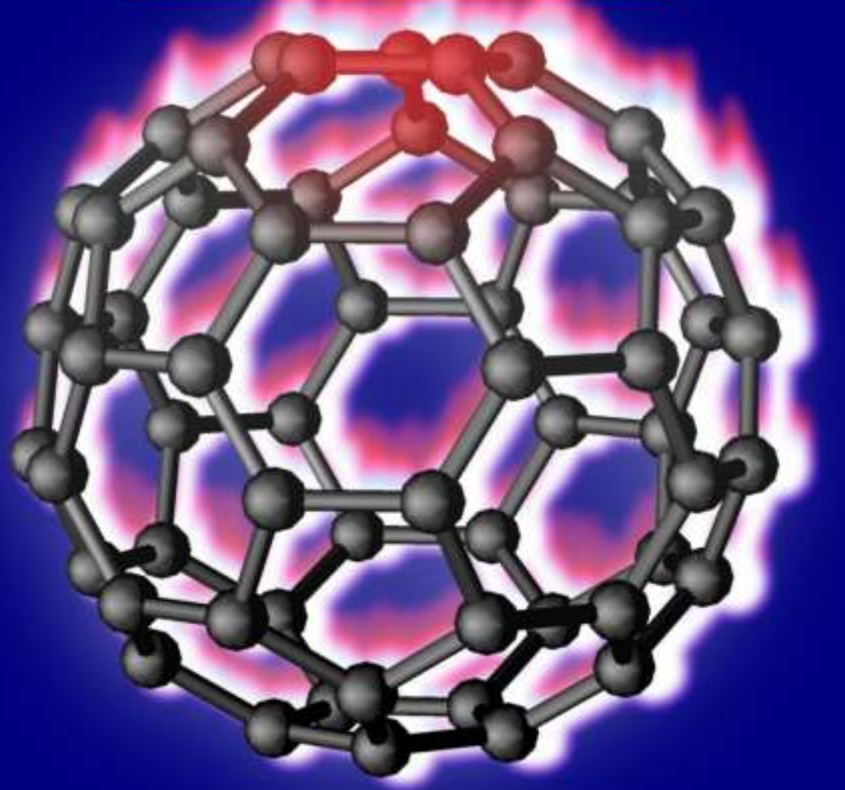
The Physics and Chemistry of Carbon and Nanoenergetic Materials



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ALMATY, KAZAKHSTAN

The Institute of Combustion Problems

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DIATOMITE: ORIGINS AND USES

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Abstract. This paper presents the results of investigation of composition of diatomite and synthesis of sorbents based on it, for further using them in water remediation.

Introduction

Diatomite is a natural material formed from the remains of diatoms, which grew and were deposited in seas or lakes. It is a loose, loosely cemented porous and lightweight rock of sedimentary origin.

The unique and unusual morphologies of diatoms have surprised scientists and engineers in various fields in the last few decades. Diatomite has its origin from a siliceous, sedimentary rock which consist principally of the fossilized skeletal remains of diatom, a unicellular aquatic plant belonging to the algae, during the tertiary and quaternary periods (Paschen, 1986; Arik, 2003).

Richard Gordon invented the word "Diatom Nanotechnology" (1988,), referring to the ways diatoms create 3D nanostructures by controlled deposition of silica in their skeletons. Minute structures made by the diatoms which are beyond the capabilities of materials scientist are attracting the attention of nanotechnologists to learn a large number of concepts from them.

Amorphous silica, a constituent of the diatom frustulae, is the main component of diatomite, although variable quantities of other materials (metal oxides, clays, salts (mainly carbonates) and organic matter) may also be present, chemical precipitation and atmospheric contact, together with the prevailing environmental conditions, are determinant factors in the nature and importance of the impurity content of a deposit (Mendioroz et al., 1989) [1].

Obtained samples based on diatomite are used in a variety of ways, such a s reinforcing, stiffening and hardening of organic solids, reducing adhesion between solid surfaces, increasing adhesion, increasing viscosity, surfactant effects, hydrophobic effects, absorbent, catalysts and cloud seeding (Zhaolun et al., 2005). Diatomite is abundant in many fields of the world and has unique physical characteristics, such as high permeability (0.1-10 mD) and porosity (35-65%) (Murer and Mobil, 2000), small particle size, low thermal conductivity and density (Hassan et al., 1999) and high surface area (Gao et al., 2005). The properties of diatomite's surface, such as hydrophobisity, solubility, charge, acidity, ion exchange and adsorption capabilities, are highly governed by the presence of water, which is partially structurally connected to the crystal mesh of the diatomite, forming active hydroxyl groups on it (Yuan et al., 1997) [1].

Diatomite consists a wide range the diatomaceous of forms and the sizes, usually from 0,4 nanometers to 200 mm, in the structure containing up to 80-90% of emptiness.

Experimental part and results

Diatoms, unicellular micro-algae, are microscopic photosynthetic plankton found almost all over where there is water. These are single-celled autotrophic organism having a highly ornate siliceous wall. They can occur in large amounts and forms (as in Fig.1), and the number of species is estimated to be over 100 000. Each type of diatom has a different formation and its own appearance as it can be seen in the Fig.1. No two species will have the same properties and features which is an attractive feature for the changing generations in the technological world. From the Fig. 1, which is SEM pictures of diversity of shapes and 3d structures in diatoms and Fig. 2, which is Optical microscopy photographs, can be seen a remarkable variety the diatom of forms, morphology and porous architecture in which some of the most widespread examples the diatom forms are visibly presented.

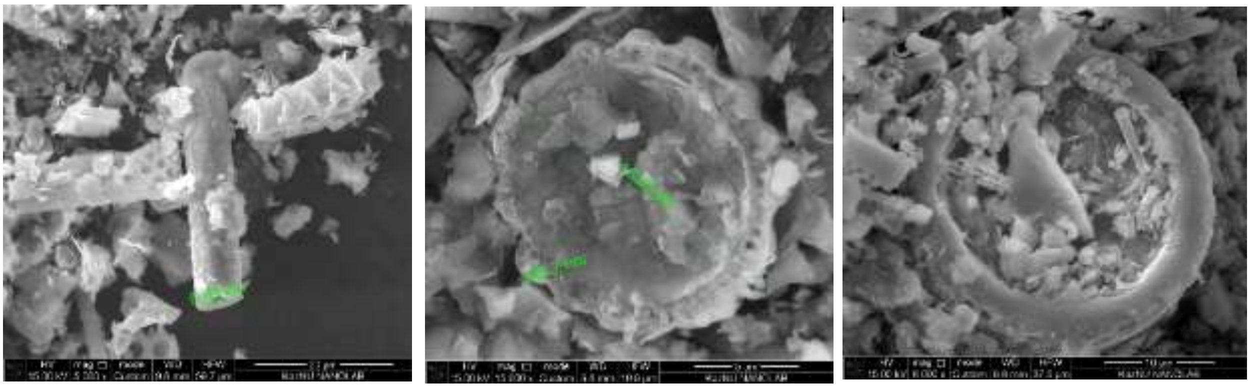

Fig.1 - Extaordinary diversity of shapes and 3d structures in diatoms built by silica

As diatomite is extracted from geological deposits, it may contain several impurity, such as organic substances and oxides of metals, namely: Al_2O_3, Fe_2O_3, CaO, MgO, K_2O, Na_2O and P_2O_5 that can have an adverse effect on its properties of application. Thus, various ways of cleaning, such as thermal preliminary calcination and washing of HCl, were usually applied to improvement of distribution of the sizes of a time on diatomite by restoration of impurity from the truncated cones.

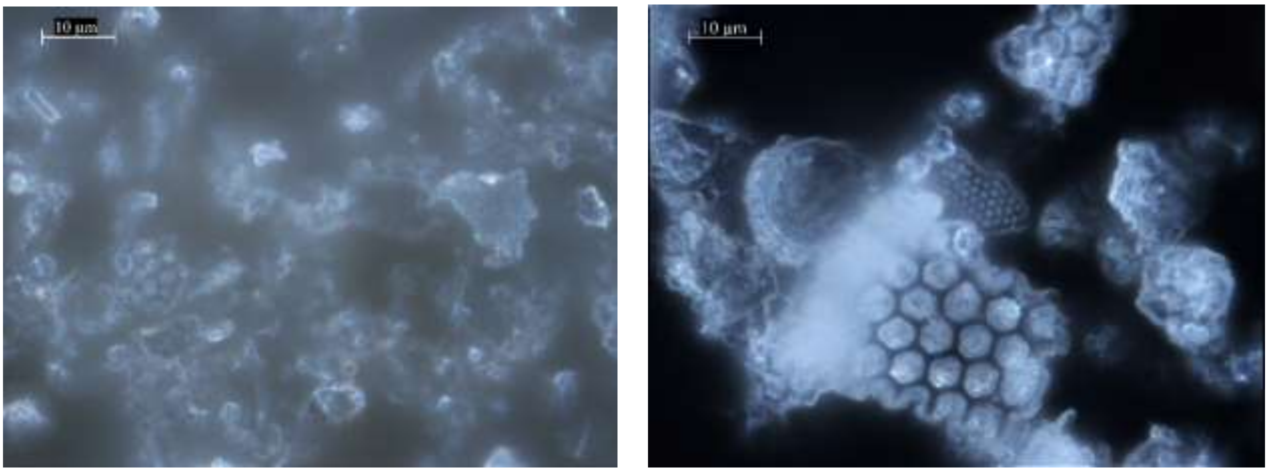

Fig.2 – Microscopic photos show the mineral composition of the diatomite original sample, the form and the appearance of the frustules

This variety of forms and ordered porous structures incontestably shows the accuracy and gloss of natural design on micro and nanoscale, giving a huge opportunity to use this material for broad application, such as the filtering environments for various inorganic and organic chemicals, as absorbents, carriers of catalysts, fillers and also in pharmaceutical area.Besides, the surface of diatomite is characterized by existence the silanol groups which are the adsorption sites for an immobilization of chemical compounds.

Thus, diatomite is special interest among natural sorption materials. Concerning the applications connected with adsorption researches for determination of potential of the raw diatomite for restoration of heavy metals in water have been conducted.

However, despite the unique combination of physical and chemical properties and large amount of deposits of diatomite, its use as adsorbent for water treatment and as a catalyst carrier or support still has not been investigated properly in Kazakhstan.

Thus, to determine the textural parameters, the volume and average pore radius of the samples of the original diatomite, was taken the nitrogen adsorption isotherm at 77 K, which is shown in Fig. 3.

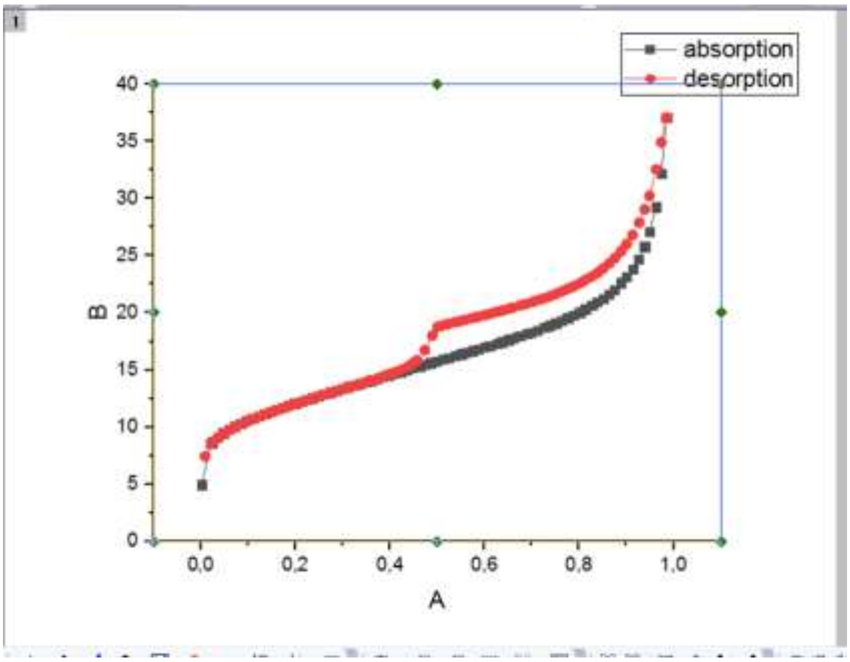

Fig.3 – Isotherms of adsorption-desorption of nitrogen for natural diatomite

That’s why, the purpose of our laboratory is studying the chemical nature and texture of Kazakhstan’s diatomite and obtaining sorbents from diatomite.

Currently, laboratory “Synthesis carbon nanomaterials in flame” working on application of diatomite for synthesis of sorbents, further using them in water remediation.

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