REVIEW
of the domestic scientific supervisor
Doctor of chemical sciences, Professor Mukhambetkali Burkitbayev

for the thesis of Zhandos Smagulovich Shalabayev

"Solid-phase and liquid-phase preparation of sulfur nanoparticles and their composites: properties study and application fields"
submitted for the degree of Doctor of Philosophy (Ph.D.) in the specialty 6D072000 – Chemical Technology of Inorganic Substances

Nowadays, elemental sulfur and its compounds are widely used in agriculture as pesticides and fungicides, production of sulfuric acid, gunpowder, fertilizers, and in medicine as an anti-biological agent. Moreover, sulfur nanoparticles and sulfur-containing nanocomposites found their application in the production of materials for lithium-sulfur batteries, anti-biological agents due to its anti-fungicidal, anticancerous, and antibacterial activity. Alkali and alkaline-earth metal polysulfide solutions nowadays are intensively used in the treatment of concrete structures in residential buildings due to hydrophobic properties of sulfur and as a growth regulatory agent and fertilizer in agriculture. Also, recently, nanocomposites based on sulfur and semiconductor copper sulfide nanoparticles are in the very intensive research interest as a cathode material in lithium-ion battery technology.

The thesis work of Zhandos Shalabayev is devoted to the synthesis of sulfur, copper sulfide nanoparticles, and sulfur-containing nanocomposites via the solid-phase and liquid-phase preparation methods. Since Zhandos could use a wide range of synthesis methods, in thesis work he selected simple, quick, environmentally-friendly, and cost-effective methods for performing research work. Using the liquid-phase method, sulfur-containing S/MCO_3 (M: Ca, Sr, and Ba) nanocomposites have been prepared at room temperature. In this part of work, adding neonol as a surfactant to the alkaline-earth metal polysulfide solutions, he showed possibilities of separating sulfur particles in nanosize treating as-obtained sulfur-containing nanocomposite with hydrochloric acid. Also, hydrophobic, anti-fungicidal, and biological properties of sulfur, carbonate nanoparticles, and S/MCO_3 (M: Ca, Sr, and Ba) nanocomposites are investigated.

Elongated needle-like copper sulfide (nCuS) nanocrystals have been prepared modifying known mechanochemical acetate route synthesis method via introducing sulfur to the reaction medium. In the results, needle-like less-selective antibacterial CuS nanocrystals were prepared showing antibacterial effect against two types of bacteria, whereas spherical CuS nanocrystals prepared by simple acetate route showed for one. Therefore, this proposed method could possibly serve as a protocol for the shape-controlled synthesis of nanoparticles using mechanochemistry, which could open a new branch of this environmentally friendly and sustainable synthetic method.

In addition, in this thesis, sulfur-containing a novel CuS/S nanocomposite have been successfully prepared by the hydrothermal and mechanochemical synthesis methods.

Research results by Zhandos Shalabayev quite fully reflected in 9 scientific publications, including 4 published abstracts in the proceedings of international conferences, in two patents, 1 article in national journals of the committee's list for publishing the main results of dissertations for the Ph.D. degree and 2 articles in scientific journals with non-zero impact factor, which is included in the Web of Science and Scopus databases.

Zhandos Shalabayev has shown himself as a self-growing young researcher. He is, hardworking, responsible, competent specialist, who able to perform independent research using various experimental methods in his dissertation. During his Ph.D., Zhandos two times has been in the laboratory of his foreign supervisor Ph.D. Matej Balaz, who is the leading scientist in mechanochemistry (department of mechanochemistry, Institute of Geotechnics, SAS, Kosice, Slovakia). There he worked on the synthesis of copper sulfide nanoparticles and sulfur-containing CuS/S nanocomposites via the mechanochemical method and tested as-obtained products for antibacterial activity.

I strongly consider that in terms of the results obtained in the thesis and the personal qualities of the applicant, the above-titled thesis of Zhandos Shalabayev meets the qualification requirements for dissertations for the Ph.D. degree, and the author deserves awarding of the Ph.D. degree in the specialty 6D072000 – Chemical Technology of Inorganic Substances.

Scientific advisor:
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РАСТАЙМЫН
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