PLASMA CHEMICAL SYNTHESIS OF NANOPOWDERS OF THE METALLOCARBON SYSTEMS

Tsvetkov Y.V.*, Samokhin A.V.
The Institute of Metallurgy and Material Sciences n.a. A.A.Baykov, RAS
119991, Moscow, Leninsky prospect 49,
Факс:(499)135 32 18 E-mail: tsvetkov@imet.ac.ru

The report contains the compilation of the results of longstanding researches conducted by the employees of the IMMS RAS, whose target was to elaborate the physical-chemical basis of the reduction and synthesis process in the hydric thermal plasma as well as to produce the dispersed nanosystems and to control these processes in order to provide the production of the intended chemical composition, form and size, especially nanosize.

According to the feasible estimates, nanotechnologies as well as the systems and production built on its basis are to become one of the most essential directions of the technological progress. The concern about nano-dispersed materials, including nano-dispersed metal powders and chemical compounds, is quite natural. Plasma chemical technology is one of the most challenging methods of the powders production.

Plasma-jet processes with the production and participation of dispersoids are the most advanced part of plasma chemical technology in the field of research methodology, physicochemistry, the principles of the constructive and technological formatting. The optimal constructive and technological formatting provides producing of dispersed nanosystems, complying the ecology and energy saving requirements.

This thesis was practically acknowledged by plasma process, which had the industrial implementation – as by the technology of plasma-hydrogen reduction of the refractory metal oxides.

In order to develop the plasma synthesis process and to produce the pilot batch, there was constructed the original multifunctional plasma set, which basic structural elements provide the scaling feature under conditions of nano-powders commercial manufacture.

Generally we can acknowledge the development of the main principles of plasma nano-powder metallurgy as the prospective research and technology area provided with the fundamental research and applicable engineering methods, which allows producing nano-structural engineering and functional materials.

We have researched the methods of metal nano-powders and compounds production in hot plasma jets of the various composition.

Along with the processes of metal soots production by means of the gas-phase condensation with the reduction of the metal oxides in hydrogen plasma jets, which found industrial application, there was offered the new scheme of plasma reduction by means of hydrogen-bearing gases, made of raw hydrocarbons in the plasma generator. The accomplishment of the reduction processes of nano-dispersed powders production in the plasma jets of the hydrocarbons partial oxidation, containing hydrogen and the carbon monoxide (the oxygen, the air, the water vapor, the carbon dioxide can be used as an oxidizer) leaves out the possibility of the hydrogen source use.

Thermal plasma, containing hydrocarbons, is a potentially productive environment both for hydrogen and hydrogen-bearing gas production and for the synthesis of carbides, carbonitrides and metallocarbon mixtures for the subsequent solid-phase synthesis of the carbide systems.

We obtained the results of the experimental research of the wolframium nano-powder production by means of the oxide reduction and titanium carbonitride synthesis in hydrocarbon-air plasma.

We have analyzed the influence of the plasma process on the condensing rate; the correlation between the form and the size of the produced particles and the condensation mode.

Recently we pay special attention to the synthesis in thermal plasma, containing hydrocarbons of the nano-powders of wolframium-carbon compositions, which under the further processing transform into nano-structural cemented carbides, which are the basis for the high-performance cutting tool with the broad assortment range and area of application.

There was established the correlation between the conducted research and ideology of the hydrogen energy, both through the industrial power complex and through the direct use of the metallocarbon nanosystems, produced in plasma, e.g., as the fuel cells catalysts.