

# Science Basis of Strengthening Treatment to Create High Performance Materials with Nanostructure, Nano-Composite and Composite Structures

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Main purpose of the research work is to develop:

- Classification of structural and energy mechanisms for strengthening materials
- Classification of strengthening methods for items, tools and parts
- Synergism of design strength for materials to form nanostructure, nano-composite and composite structures
- Classification of composite structures formed by means of hardening treatment
- Classification of strengthening methods for items, tools and parts
- The simple, inexpensive and high-performance and ecologically clean methods for strengthening materials to form composite structure;

*Classification of structural and energy mechanisms for strengthening materials is based on:*

- Theory of metastability system
- Dislocation theory
- Friction theory
- Corrosion theory

*Classification of strengthening methods for items, tools and parts to form composite structures is based on realization of structural and energy mechanisms and includes:*

- Methods for technological treatment
- Metallurgical and other methods for manufacturing materials
- Design and operation methods

*Synergism of design strength (between strength and reliability criteria) for materials is based on the creation of composite materials with non-uniform structure, rationally having opposite properties of its macro- and micro(nano) elements. All composite materials can be divided into 3 levels:*

- Composite materials from alternating macroelements (matrix, layer) with various properties
- Composite materials from alternating micro(nano)elements (grains, sub-grains, particles) with various properties
- Composite materials from micro(nano)elements which have directed changes of their properties

*Classification of composite structures formed by means of strengthening treatment includes:*

- Structure of composite materials with interchanging macro-elements (matrix, layer) and various properties
- Structure of composite materials with interchanging micro-(nano-)elements (grains, subgrains, particles) and various properties
- Structure of functionally gradient materials of micro-(nano-) elements that directionally change their properties

The new hydro chemical treatment method for hardening ready-made parts and tools made from steels, hard alloys, ceramics and diamond materials is developed. This treatment permits decreasing the friction coefficient of the tool steel surface in 8,3 and hard alloy surface in 3,9 as compared with untreated. Besides in materials at a depth of 1 mm; a zone of compression stress (180–470 MPa) is formed. As a result the operational resistance of steel, hard alloy and diamond tools has been increased by the factor of 1.5-8.0 in comparison with the standards.