NANOTECHNOLOGY AND ENVIRONMENT

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Introduction

The newest nanoprocess designs and knowledge obtained recently about biosphere [1, 2] evidence the necessity of taking into account unknown before environmental factors. Every year all new matters appearing as result of mankind activity are added to the chemical agents of a biosphere. Therefore, to present the scale of new problems facing to ecological science, first of all it is necessary to locate nanoscience among other natural sciences and to understand its correlation with ecology.

In the given message the questions of correlation and intercoupling of nanoscience and Ecology, nanotechnology and biosphere are considered.

The field of action for modern Ecology and nanoscience

Depending on dimension and complexity of organization and subject to classification of nanoobjects according to [3] animate and inanimate nature objects might be divided conventionally into 23 levels (Table 1). Including biostructures (column on the right) their list starts from subfundamental quarks-type particles and ends to Universe on the whole. With the help of this scheme the levels covered modern natural sciences may be shown rather legibly.

For example, Biology 3–17 levels. Chemistry studies first of all 2–7 levels, but application its laws is extended to 8–21 interval.

The general laws of Physics are concerned all levels, though the scientists study today maximum actively objects observed on the both ends of this list (1–7 and 17–23).

1–7 levels, which called conditionally «nanocosm», nanoscience studies by vocation, but in the near future its laws will be allowed on all 1–23 levels.

6–18 levels are allowed at present by consideration of ecological problems first of all, but in the near future, being cooperated with other sciences, including nanoscience, Ecology will be extended to the highest (19, 20) levels and to the lowest (3–6) levels.

	Inanimate nature		*Animate nature*
Megacosm	???		
	Universe	**23**	
	Galaxy system	**22**	
	Galaxy	**21**	
	Planetary system	**20**	
	Planets	**19**	
	The Earth	**18**	???
Macro	Inanimate bodies	**17**	Biosphere
		16	Ecosystem
		15	Grouping
	and agents	**14**	Population
		13	Organism
		12	System
		11	Organ
		10	Tissue
Microcosm	Dust, silt, sand (*middle diameter* d>1 μm)	**9**	Cell
		8	Protoplasma
Nanocosm	Ultra dispersed particle (d>30 nm)	**7**	Bacterium (d>100 nm)
	Colloidal metal, black, aerosol (d=10-30 nm)	**6**	Virus (d>10 nm)
	Cluster compound of metals, 3 – 2×10^4 atoms (d=0.55-10 nm)	**5**	Molecule
	Binuclear compound, coupling metal-metal (d=0.45–0.60 нм)	**4**	
	Mononuclear compound of metals (d=0.24-0.34 nm)	**3**	
	Fundamental particle	**2**	
	Subfundamental particle	**1**	
	???		

Table 1. Organization levels of a substance and the field of action for modern Ecology and nanoscience.

Correlation and intercoupling of nanotechnology and biosphere

The pollutions of the environment called by nanostructural particles are possible to divide conditionally into two parts:

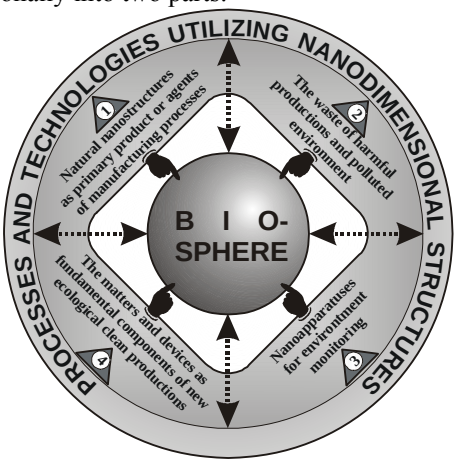

Fig. 1. Scheme, indicating the correlation and the intercoupling of nanotechnology and biosphere.

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a) the pollutions, related to the current engineering (for example, nanoparticles in exhaust gases of diesel motors etc.) and with the current industrial productions (for example, the use of quartz and asbestos fibres etc.);

b) the pollutions, related to the new matters and manufacturing processes.

In many cases the nanotechnologies represent the new manufacturing processes, and their potential hazard to an environment should be studied and estimated carefully. Stable and insulated nanoparticles can be utilized as structural elements of materials or as independent objects in more large-scale or passive structures. On the scheme (Fig. 1) four groups of objects of an environment, related to production and spreading of nanostructural materials, are selected (groups are indicated in numerals 1, 2, 3, 4).

Natural nanostructures, used as primary product or agents of manufacturing processes are objects of the first group:

- the zeolites and other porous rocks as ion-exchangers in water-purification systems;
- clay and zeolites as shielding materials in radioactive waste storages;
- inorganic fertilizers for adjustable allocation of iron, phosphorum and other nutrient materials from them;
- the aluminosilicates for introducting in foodstuff as the structuring agents (for example, producing unlactic dietary cream) or the zeolites as the components in forage promoting the fast growth of animals;
- silica gel and others nanophase solid matters as dehydrating agents (desiccants).

The waste of harmful productions and polluted environment are objects of the second group:

- the particles of pollutants located in water (< 300 nm) are possible to isolate with the help of materials based on modified carbon nanotubes and inorganic fullerenes, possessing particular chemical functionality and selectivity;
- dangerous organic compounds, cells, viruses and toxicant chemicals located in air (< 20 nm) are possible to isolate with the help of nanodimensional TiO_2 particles, subjected to the ultra-violet treatment;
- the atoms of heavy metals binded by nanodimensioned absorbers or by passivation of a polluted surface;
- habitability environment on space stations and in closed rooms, supported by regenerating systems;
- a waste on dumps recycled by binding of pollutants with nanostructural materials at their introducing into effluent as the active agents.

The third group include *nanoapparatusses for monitoring of environment* containing nanoparticles; for research and control of products and waste of chemical productions:

- the counters of nanoparticles, grown by condensation from a gas phase, allow the registration of particles less than the 3 nm size in air;
- the devices permit to register particles the 1 nm size and less within several seconds by the analysis of differential movability of nanoparticles (particles, charged by a single plus - minus charge, are moved under operating of an electrical field across a flow free of nanoparticles. They are discharged as monodispersed aerosol).

The matters and devices as fundamental components of new ecological clean productions are included in the final fourth group:

a) an increase in power efficiency and a reduction in harmful waste in systems for energy conversion:

- the nanosystems can be the basis for productions of renewable power sources with much less harmful emissions – battery electrodes, electrodes of fuel cells for vehicles etc. (for example, the use of V_2O_5 aerogel in cathodes of lithium batteries and of the nanodimensional components in cathodes of Ni-MeH batteries and replacement of ecological harmful Ni-Cd batteries) by them;
- the nanodimensional reagents increase efficiency of catalytic reactions (reactions rate, products yield);

b) the composite nanomaterials can be utilised for infiltration systems (for example ordered mesoporous material MCM-41), and as materials for protective shields;

c) the oriented single-wall carbon nanotubes as materials for cold emission and ecologically safety displays;

d) the matters for regulation of a drug preparations transfer inside an organism, materials of an effective dialysis, high-performance drug sorbents.

Every year the above list of objects is enlarged. However, the interdisciplinary researches of molecular and nano-scale processes in natural systems are necessary to perform for a more effective application of ecological clean nanotechnological processes. Thus, the special attention should be given to analysis of an interaction between organic and inorganic structures in nano-scale processes.

Conclusions

The preferences of the nanotechnologyies may be realized in a maximum degree and without damage to an environment under condition of accurate comprehension of correlation and intercoupling of nanotechnology and biosphere.

The processes, occurring at the interfaces of animate and inanimate nature, in many respects determine a biosphere condition. The analysis of dynamics processes, specific for nanostructures, will allow us to understand the mechanisms of transfer and application of nanotechnologies to improve the ecologically situation.

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