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The Choice of Technology Obtaining Nano-Sized Modifiers for Construction Composites

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Abstract

There are various methods of obtaining nanopowders, which can be used for the construction of composites. To determine the rational technology of nanoscale modifiers in this paper we propose a generalized criterion that takes into account such criteria as the criterion of private energy efficiency technologies criterion of self-organization of matter, the criterion of structural stability and particle size criterion.

Keywords: nanoscale modifiers, technology acquisition, generalized criterion

1 Introduction

The methods of receiving nanopowders developed so far are very various. The literature provides a dozen classifications of these methods for a variety of physical and chemical principles [1…6].

For example, there are methods of classification on the basis of changes in particle size during synthesis:

- air dispersion method (based on the dispersion of raw materials);
- condensation methods (based on the preparation of nanoparticulate systems in which substances are dispersed on a molecular (atomic) level).

No less productive and logical classification of methods is the state of aggregation of the starting materials:
- gas phase;
- liquid phase;
- solid phase.

What is the method of obtaining the synthesis of nanopowders select the desired connection? The choice depends on the chemical nature of the compound, its particle size desired and the available experimental basis in the laboratory. The most simple, does not require complex hardware design methods for the preparation of complex oxides - precipitation methods, combustion kompleksonatny method and polymer-salt compositions. The sol-gel method is also simple, but usually to produce a fine product as precursors required inaccessible metal alkoxides. Pretty easy to implement as well as a microwave hydrothermal method in the presence of a laboratory autoclave and microwave.

2 Experimental study

To determine the rational technology of nanoscale modifiers form the generalized criterion containing the following particular criteria (table 1):
1) the criterion of energy efficiency technologies;
2) criterion is equipped with traditional equipment;
3) the criterion of self-organization of matter;
4) the criterion of structural stability;
5) the criterion of the particle size.

Generalized criterion for selecting the direction of the modification should be presented in the form of:

$$k_{ef} = \sqrt[5]{k_e \cdot k_{eq} \cdot k_{sm} \cdot k_s \cdot k_d}$$

Table 1: Group properties and their quantitative assessment

№	Name criterion	Calculated formula	Explanations
1.	The criterion of energy efficiency technologies	$k_e = \frac{\Sigma T_o t_o}{\sum_j^m T_j t_j}$	T_o, t_o – respectively, and the temperature and stage of the process of energy-efficient production of nano-sized modifier; T_j, t_j – respectively temperature and duration of step synthesis process modifier nano
2.	Criterion is equipped with traditional equipment	$k_{eq} = \frac{n}{N}$	n – the number of existing equipment with traditional technology; N – amount of equipment required to produce nanoscale modifiers.

Table 1 (Continued): Group properties and their quantitative assessment

3.	The criterion of self-organization of matter	k_{sm}	k_{sm}=1,0 – with self-organization of matter; k_{sm}=0,5 – the synthesis of energy-intensive structures.
4.	The criterion of structural stability	k_s	k_s=1,0 – thermodynamically stable compounds; k_s=0,5 – unstable compounds in the synthesis of.
5.	The criterion of the particle size	$k_d = \frac{d_{50}}{\bar{d}}$	at $k_d > 1$ accept $k_d = 1{,}0$ or d<50 nm – $k_d = 1{,}0$

3 Results and discussion

The value of private and generalized criteria determined by applying rd expert method. The results obtained are summarized in table 2.

Table 2: Values of the partial and generalized criteria for selecting technology of nanoscale modifiers

№	Name method	The values of the partial criteria					The value of the generalized criterion
		k_e	k_{eq}	k_{sm}	k_s	k_d	
1.	Mechanical crushing	0,2	0,95	1,0	0,5	0,6	0,56
2.	Ultrasonic dispersion macroscopic particles in solution	0,25	0,8	1,0	0,5	0,9	0,62
3.	Mechanical synthesis of nanoparticles and nanocomposites	0,2	0,95	1,0	0,5	1,0	0,62
4.	Decomposition method	0,95	0,93	1,0	1,0	1,0	0,98
5.	By chemical vapor deposition (co-precipitation)	0,8	0,98	1,0	1,0	0,9	0,93
6.	Sol-gel method	0,8	0,98	1,0	1,0	0,9	0,93
7.	Hydrothermal method	0,85	0,92	1,0	1,0	0,93	0,94

Table 2 (Continued): Values of the partial and generalized criteria for selecting technology of nanoscale modifiers

8.	Method kompleksonatnoy gomogenizazii	0,8	0,9	1,0	1,0	0,85	0,91
9.	Solvent exchange method	0,9	0,8	0,5	0,5	1,0	0,71
10.	Synthesis under microwave irradiation	0,92	0,85	1,0	1,0	1,0	0,95
11.	Method RTDS	0,91	0,68	0,5	0,5	0,85	0,67
12.	Spray drying	0,87	0,6	1,0	0,5	0,9	0,75
13.	Method RESS	0,89	0,71	0,5	1,0	0,9	0,78
14.	Cryochemical method	0,82	0,72	1,0	1,0	0,9	0,88
15.	Glycine-nitrate method	0,8	0,68	0,5	1,0	0,85	0,75
16.	Method Pechini	0,92	0,9	1,0	1,0	0,4	0,80
17.	Cellulose (cloth, paper) technology	0,9	0,9	0,5	1,0	0,85	0,81
18.	Pyrolysis of polymer-salt films	0,61	0,85	0,5	1,0	0,85	0,74
19.	Plasma-chemical method a) processing of gaseous compounds in the plasma b) processing the drip-liquid feed c) treatment of solid particles suspended in the flow of plasma	 0,56 0,58 0,6	 0,5 0,6 0,48	 0,5 0,5 0,5	 1,0 1,0 1,0	 0,85 0,6 0,8	 0,65 0,64 0,65
20.	In the flame hydrolysis method	0,56	0,63	0,5	1,0	0,75	0,67
21.	Impulsive laser evaporation method	0,61	0,7	0,5	1,0	0,9	0,72
22.	Molecular beam method	0,46	0,71	0,5	0,5	0,95	0,60
23.	The aerosol method	0,52	0,72	1,0	1,0	0,85	0,80
24.	Method kriokondesatsii	0,6	0,73	0,5	1,0	1,0	0,74
25.	Electric explosion of metal wires	0,7	0,4	0,5	1,0	0,9	0,66

Table 2 (Continued): Values of the partial and generalized criteria for selecting technology of nanoscale modifiers

26.	Getting nanofibers -sol-gel method -kondensatsiya gaseous phase	 0,78 0,82	 0,8 0,75	 1,0 1,0	 1,0 1,0	 0,9 0,9	 0,89 0,89
27.	Preparation of dispersed phases of the hollow spherical particles and tubular	0,75	0,72	0,5	1,0	0,85	0,75

4 Conclusion

Analysis of table 2 shows that the most efficient technology of obtaining of nanoscale modifiers to modify the structure and management of the properties of composite construction appropriate to apply:

- method of decomposition;
- the method of chemical vapor deposition (co-precipitation);
- sol-gel method;
- hydrothermal method;
- method kompleksonatnoy homogenization;
- synthesis under microwave irradiation.

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