SOME NEW APPROACHES TO SYNTHESIS OF FUNCTIONAL MATERIALS OF TYPE NANOPARTICLES IN POROUS MATRICES

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Some substances with attractive properties in bulk state (active phase) have low specific surface area S or cannot be prepared as granulated materials. Their deposition on surface or incorporation in framework of support allows to overcome indicated shortcomings. Besides, it is well known that embedded or formed in porous matrices particles possess singular physical, chemical, catalytic properties owing to achievement of nanodispersed state and limiting influence of pore walls on enlargement of particles (confinement effect). In this study, several substances which have very different nature and are used in various fields of science and technology (barium titanate, polyoxometallates, zirconium phosphate, titanium, vanadium, molybdenum oxides) were prepared as compositions with supports (silica, titania, alumina). Following pathways were applied for this purpose:

1) Sol-gel procedure with simultaneous formation of porous matrix and embedding of active phase or its precursor in structure. Composites containing 20-40%w/w of barium titanate in form of nanocrystals size of 5-20 nm and possessing specific surface area 20-230 m^2/g and total pore volume V_Σ=0.2-0.4 cm^3/g were produced with the help of this method. Compositions of polyoxometallates and zirconium phosphates with silica have micro-mesoporous structure with S=450-920 m^2/g, V_Σ=0.2-0.6 cm^3/g and micropore volume to 0.15 cm^3/g.

2) Mechanochemical deposition of active phase on surface of made-ready support. In this case using of nonporous supports (for example, fumed oxides) is preferable. If the milling is carried out in air resulted compositions remain nonporous. At the same time, treatment in water results in formation porous structure, as a rule, meso- or meso-macroporous. In both cases, nanoparticles size of 15-30 nm are formed on surface of support or inside the pores, the volume of which vary between 0.5-1.5 cm^3/g.

3) The dispersion of nonporous fumed silica or alumina in the preliminarily prepared peroxide solution of oxides of transition metals. In this case, similarly, simultaneous formation of porosity and deposition of active phase on surface are observed.

It should be noted that the first two pathways permit to introduce precursors on surface or in the structure of matrices. Their thermal decomposition leads to appearance of active phase nanoparticles smaller than 10 nm. Compositions prepared via techniques 2 and 3 differ by larger porous structure and absence of micropores.

Therefore, proposed approaches allow to prepare compositions containing functional moieties with regulated porous structure parameters, size, and morphology of nanoparticles.