Formation of Interatomic Bonds on the Fumed Synthesis of Composites x-SiO_2 +y-Al_2O_3

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Consolidation of unique properties of different nanomaterials allows broadening the range of their applications. In contrast to coarse-crystalline materials synthesis of composite nanomaterials can cause appearance of new properties due to significant contribution of interatomic interaction of surface atoms of nanoparticles.

Due to minimal uncontrollable influence of consequences of oxidation of nanoparticles surface in nanooxides and their unique sorption, photo-catalytic and photo-destructive properties they are important objects for investigation of influence of interatomic interaction changes at different treatment methods of nanooxides mixtures on formation of their properties.

The O$K\alpha$- , Si$L\alpha$- and Al$L\alpha$-emission spectra of mechanic mixes in system x – SiO_2 + y –Al_2O_3 (x=0,8 and y=0,2; x=0,7 and y=0,3; x=0,25 and y=0,75) and fumed synthesis of composites were investigated by the ultra-soft X-ray emission spectroscopy method.

The low-energy widening and shift of the main peak of superposition of the O$K\alpha$-emission bands of mixtures by 1,0 eV in a fumed mixed that indicates significant decrease of the energy of the Op-electrons occupying non-binding states. It was found that intensity of the low-energy sub-band reflecting covalent-binding states decreased when increasing Al_2O_3 content. Investigation of the Si$L\alpha$- and Al$L\alpha$-emission bands showed in fumed composites electrons occupation of states in low-energy sub-bands increased in Al$L\alpha$ (by 10 %) and in Si$L\alpha$ (by 50 %).

It was shown that such energy redistribution of the electrons is a consequence of formation of O-Si-O-Al-O chemical bonds at fumed synthesis of composites. Increase of occupation of low-energy Si and Al sub-bands and decrease of contribution of the Op-states into the covalent-binding sub-band of the O$K\alpha$-spectrum is a consequence of electron charge transfer from oxygen to s-states of silicon and aluminum. It leads to shift of the electron density to cations in σ-binding orbitals. Formation of the Op-π-bonds caused a decrease of the energy of Op-states occupied non-binding states.