THERMAL SYNTHESIS OF METAL-CARBON NANOCOMPOSITES BASED ON SYNTHETIC HUMIC SUBSTANCES

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Interest in nanostructured materials, which include nanoparticles of ferromagnetic metals in a carbon matrix, is caused by specific magnetic properties manifested in the nanoscale state: high magnetization, the ability to change the values of the coercive force due to the dependence of this value on the size of nanoparticles, lower Curie temperature, high anisotropy, etc. For example, composite materials containing 3d-metal nanoparticles (Fe, Co, Ni) are of interest from the point of view of their use as heterogeneous catalysts in various chemical processes, components of dispersed radio-absorbing media in high-frequency devices, magnetic resonance imaging, and biomedicine.

We have proposed a new method of producing metal-carbon nanocomposites (Fe/C, Co/C, Ni/C), which includes three stages: 1) obtaining synthetic humic substances by oxidation of pyrocatechol with molecular oxygen in alkaline medium; 2) obtaining a metal humate by adding $Fe(NO_3)_3$, $Co(NO_3)_2$ or $Ni(NO_3)_2$ to a solution of synthetic humic substances; 3) reduction of Me^{n+} ions by pyrolysis in a hydrogen medium. The use of carbon-containing precursors on the basis of synthetic analogues of humic substances is due to the absence in their composition of the ordered structural fragments, from which the nanocrystal of carbon atoms can be obtained in the conditions of pyrolysis. At full stochastic structure the humic substances are characterized by the well-defined indicators content functional groups. The presence of carboxy-groups, quinoid fragments and phenolic hydroxy-groups in the structure of synthetic humic substances determined their ability to form salt and complexes with polyvalent cations of transition and non-transition metals. Carrying out the pyrolysis of the humates of iron group metals in the reducing atmosphere of H_2 removes almost completely the contained oxygen from the final product in the humic substances, partly in the form of CO_2 and partly in the form of water. Ions of the transition metal in these conditions are reduced to the metal atoms, forming nanoparticles surrounded by a grid of the randomly connected in a rigid structure of linear and cyclic carbon blocks. The pyrolysis temperature influence on the metal nanoparticles size and nature of the carbon matrix was investigated.

The structure and composition of the products were characterized by X-ray diffraction (Fig. 1), transmission electron microscopy, voltamperometry, and elemental analysis.

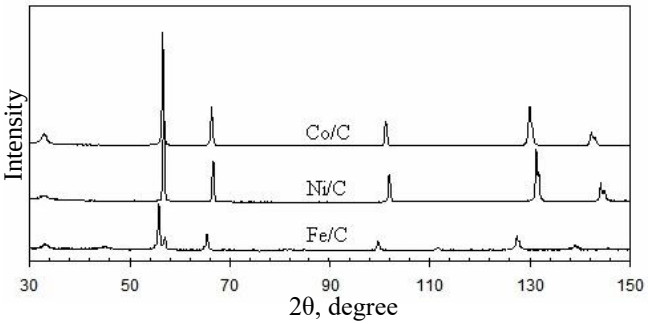

Fig. 1. The X-ray powder diffraction patterns of metal-carbon nanocomposites