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ZEOLITE-BASED CATALYSTS FOR SYNTHESIS OF CARBON NANOTUBES

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Abstract

Supported transition-metal catalysts were prepared on zeolite by self-propagating high-temperature synthesis method and were tested upon receipt of carbon nanotubes by CVD. The effectiveness of zeolite as matrix for catalysts in chemical vapor deposition synthesis of multiwall carbon nanotubesis is presented here. Obtaining of carbon nanotubes on zeolite-based catalysts was characterized by the transmission and scanning electron microscopy as well as Raman spectroscopy. For catalyst of zeolite-Co_3O_4 the carbon nanotubes have a diameter of 11 nm. For catalyst of zeolite-Fe_2O_3 the carbon nanotubes have a diameter from 7 to 21 nm. Raman spectrum indicates at low defectiveness of obtained carbon nanotubes.

Key words: zeolite, catalyst, self-propagating surface thermosynthesis, carbon nanotube

Introduction

Carbon nanotubes due to their unique physico-chemical properties are called as «materials of the future» [1] it's triggered an exceptional splash during investigating of the carbon nanomaterials. Carbon nanotubes are used in many application fields such as energy, biotechnology, microelectronics, textile, etc. [2-4]. The producing of composite materials on the basis of carbon nanotubes is one of the main application fields. There are many methods for the synthesis of carbon nanotubes such as electro arc, CVD synthesis, flame synthesis [5], etc. Currently, CVD method is recognized as the leader in synthesizing of CNTs.

CVD method is an inexpensive system, and there is a feasibility to use different catalysts and various carbon containing sources in solid, liquid and gas forms.Structure and properties of carbon nanotubes depends on many factors: initial components, composition and structure of catalyst, synthesis conditions and other. The catalysts methods are applied for synthesis of carbon nanotubes.

Frequently, the catalyst is the complex of matrix and active phases. The catalysts on the basis of transition metal particles from fine metal or their compounds such as salts and oxides are the most effective in the synthesis process of carbon nanotubes. The silicon wafers [6], aerogels, quartz, mesoporous silica [7] are used as matrixes for the catalyst. Carbonaceous precursors are decomposed into catalytic nanoparticles but the carbon is diffuse through a catalytic nanoparticle and sprout into CNTs. There are two main model of carbon nanotubes growth: «tip-growth model» and «base-growth model».

Depending on composition and structure of the catalyst there is one or the other growth mechanism. The choice of matrix for catalysts, its structure predetermines the properties of final product. Creation of new catalytic systems with various composition of active phases and matrix allows obtaining the carbon nanotubes with different morphology and properties.

Experimental

Obtaining of catalyst

It must be considered the nature of transition metal when choosing the catalyst. In series of transition metals from Ti to Ni, the bonding force M-C with filled electrons of d-level is rising [8]. The formation of strong bindings such as Ti, V, Cr with carbon is determine their low catalytic activity. For this reason such catalyst as oxides of cobalt and iron were used.

For preparation of catalysts the synthetic zeolite (80 % is silicon oxides) with apparent density of about 0.9187 g/cm^3 was used. The zeolite has a structure of thin scaly plates. Previously, the zeolite was heated at a temperature of 1000 °C for