N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
PHYSICO-MATHEMATICAL SERIES
ISSN 1991-346X
Volume 3, Number 319 (2018), 14 – 22

UDC 539.23; 539.216.1

Ye. Yerlanuly[1,3],D.G. Batryshev[1,3], , T.S. Ramazanov[2], M.T. Gabdullin[3], N.E. Ahmetzhanov[3], N.E. Ahanova[3,4], O. Omirzhanov [1]

[1]Laboratory of Engineering Profile, Al-Farabi Kazakh National University;
[2]Scientific and Research Institute of Experimental and Theoretical Physics,
Al-Farabi Kazakh National University;
[3]National Nanotechnological Laboratory of Opened Type, Al-Farabi Kazakh National University
71, Al-Farabiavenue, Almaty, 050040, Kazakhstan;
[4]Kazakh-British Technical University, Kazakhstan
yerlanuly@physics.kzbatryshev@physics.kzramazan@physics.kzgabdullin@physics.kznazym@physics.kz

EFFECT OF PLASMA PARAMETERS ON THE SYNTHESIS OF CARBON NANOMATERIALS BY THE PECVD METHOD

Abstract: This work covers an experimental study of the effect of plasma parameters on the synthesis of carbon materials by the PECVD method. It was found that, depending on PECVD synthesis parameters,in particular, temperature, discharge power, gas pressure, percentage of gas mixture and etc., various carbon nanomaterials are synthesized. The obtained samples were analyzed by using analytical equipment such as Quanta 3D scanning electron microscope (SEM, FEI USA), NThegra Spectra Raman spectroscopy and Leica optical microscope. Thus, the morphology and quality of the structure of the obtained samples (carbon nanoparticles (CNP), carbon nanofibres (CNF) and nanotubes (CNTs), carbon nanowalls (CNWs) and multilayered graphene sheets) were studied by optical and electron microscopies, as well as by the method of combined light scattering. Found, that with the increase of power of the radio-frequency discharge, the production of qualitative nanostructures is complicated by the formation of their nanoclusters. For the synthesis of CNT, it is necessary to control the thickness of catalytic nanolayer, since the quality of CNT structures can be worsened by the formation of thicker nanofibers. The obtained experimental results can be used to determine the optimum PECVD synthesis condition to synthesize various carbon nanomaterials.

Keywords:carbon nanoparticles, carbon nanofibers, carbon nanotubes, carbon nanowalls, multilayer graphene, radio-frequency (RF) discharge plasma.

Introduction

Analysis of the state and trends in the modern development of nanoindustry objects allows us to conclude that one of the most promising areas of nanotechnology is the production of carbon nanomaterials (CNMs). As is well known, carbon exists in the solid phase in several modifications, the properties of which sharply differ from each other: carbon nanoparticles [1-2], carbon nanofibres, carbon nanotubes [3-4], graphene [5-6], carbon nanowalls [7- 8], fullerene [9] etc. The research relevance of CNMs is due to the wide range of their practical application in various areas of industry. For example, carbon nanoparticles can find their application in water purification [10,11], automobile tires as reinforcing fillers [12], in determining cancer cells at an early stage [13], etc. Scientists suggest the use of carbon nanotubes as reinforcing elements for the production of high-quality concrete [14,15] in construction. The unique properties of CNTs are also used for medicine purposes like water disinfection, production of antimicrobial coatings and drugs [16] and in targeted drug delivery [17]. CNTs and composites based on them are used in power engineering to store hydrogen [18], to create high-capacity capacitors (supercapacitors) [19]. The unique semiconductor properties of graphene allow them to be used in electronics to create highly sensitive sensors, high-speed electronic devices [20,23] etc. As for carbon