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# ХИМИЯ ЖӘНЕ ХИМИЯЛЫҚ ТЕХНОЛОГИЯ БОЙЫНША X ХАЛЫҚАРАЛЫҚ БІРІМЖАНОВ СЪЕЗІ

# X МЕЖДУНАРОДНЫЙ БЕРЕМЖАНОВСКИЙ СЪЕЗД ПО ХИМИИ И ХИМИЧЕСКОЙ ТЕХНОЛОГИИ

# 10th INTERNATIONAL BEREMZHANOV CONGRESS ON CHEMISTRY AND CHEMICAL TECHNOLOGY

*24-25 қазан 2019 ж., Алматы, Қазақстан*
*24-25 октября 2019 г., Алматы, Казахстан*
*October, 24-25, 2019, Almaty, Kazakhstan*

## СЕКЦИЯ 5. СОВРЕМЕННЫЕ ПРОБЛЕМЫ ПЕРЕРАБОТКИ УГЛЕВОДОРОДНОГО СЫРЬЯ

# MULTIWALL CARBON NANOTUBES ON DIATOMITE

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Diatomite is a silicon dioxide mineral containing fossilized skeletal remnants of one-cell water plants called diatom algae. It has a number of significant advantages: high specific surface area, easily regenerate.

Diatomite is cheap material and has many practical applications. There are many diatoms around the world, thus, it can be assumed that in future it will be applied in many areas. One of these areas is obtaining composite material based on diatomite and multiwall carbon nanotubes (MWCNT).

Chemical vapour deposition (CVD) method is usually used for synthesis of carbon nanotubes due to its several advantages. This method allows decomposing carbon-containing substances into catalytic particles of metallic elements (Fe, Ni, Co). Synthesis of MWCNTs by CVD method is a process which produces high purity solid materials. The catalyst exerts a great influence on the structure, characteristics and yield of the carbon material [1, 2].

The authors of [3] have developed a technique for producing a porous carbon material, which is utilized to grow CNTs.

The activities and selectivities of both catalysts were compared in [4]. In 2009 El-Shazly Duraia and his coauthors [5] synthesized single wall carbon nanotubes (SWCNTs) on diatomite by plasma-enhanced chemical vapor deposition, which was characterized by Raman spectroscopy and Scanning Electron Microscope.

In work [6] magnetic MWCNTs were synthesized based on diatomite by CVD method. The obtained composite showed superparamagnetic properties and was employed as a sorbent in water purification.

Raman characteristics provides unique and useful information about various types of carbon nanostructures. Researchers commonly employ this method to identify quality of carbon nanotubes (CNTs), their purity and defectiveness. Raman spectroscopy is a non-destructive technique for the detailed determination of structural characteristics of single-wall carbon nanotubes [7].

Multiwall carbon nanotubes obtained by chemical vapour deposition method. The typical schematic of the CVD apparatus is given in [8]. Propane-butane mixture used as a carbon-containing gas, and diatomite was used as a catalyst carrier. This system consists of oven with a 35 mm and 450 cm quartz reaction tube. The central part of the reactor can be heated to 1000°C. The measurement of temperature was made by a chromel-alumel thermocouple. The growth was carried out by catalytic decomposition of a propane-butane gas mixture on a diatomite substrate with a preliminary prepared catalyst.

The samples containing carbon nanotubes characterized by Raman scattering method using the 473 nm laser and Solver Spectrum instrument (NT-MDT) at the National Nanotechnology Laboratory of Open Type of al-Farabi Kazakh National University. The laser beam was directed on the sample using a 100×0.75 NA Mitutoyo lens provided a laser spot of <2 μm. The scattered light was collected in back-reflection geometry via the same lens. All spectra were normalized and the width and intensity of the peaks were studied using Origin software.

The Raman characteristics of MWCNT showed the four characteristic peaks: D band at about 1360 $cm^{-1}$, G band at 1580 $cm^{-1}$, 2D (G') band at 2710 $cm^{-1}$ and D+G band (also assigned as D+D') at about 2930 $cm^{-1}$. The D band indicates the presence of defects in the MWCNT sample. They are carbon impurities with $sp^3$ bonding or dangling $sp^2$ bonds at the edges. The G band is due to $sp^2$graphitic nature of the sample and its full width at half maximum (FWHM) can indicate the crystallinity of the sample. The 2D band is associated with the long-range order in a sample mainly along the crystallographic *c*-axis and also provides information on the number of walls. The 2D peak arises from the two-phononsecondorder scattering process that results in creation of an inelastic phonon [9], no defects are required for its activation. D+G band is combination of phonons with different momenta and thus it requires a defect for its activation [10].

It was concluded that the reaction temperature increase leads to rise of CNTs crystallinity and diameter.

Natural diatomite was employed to synthesize multiwall carbon nanotubes. The samples were analyzed by Raman spectroscopy. The quality of MWCNT was shown to strongly depend on the synthesis conditions. Nanotube crystallinity and diameter increase when temperature rises. Thus, the diatomite with its inherent high specific surface was proved to be a suitable substrate for the synthesis of carbon nanotubes.

Development of new methods for creation of catalytic systems, which allow controlling the structure of carbon particles is an important task leading to the improvement of the existing approaches to the synthesis of CNTs with definite functional properties.

Thus, considering the changes in all the three peaks – D, G and 2D, it can be concluded that increase of the reaction temperature leads to the increase of not only the crystallinity, but also the diameter of the synthesized carbon nanotubes.

**Acknowledgements**

The work was supports by a grant from the Ministry of Education of the Republic of Kazakhstan: AP AP05133836 "Obtaining nanostructured materials based on diatomite for water purification".

**References**

1. LobiakE.V., ShlyakhovaE.V., BulushevaL.G., PlyusniP.E., ShubinYu.V., OkotrubA.V.Ni–Mo and Co–Mo alloy nanoparticles for catalytic chemical vapordeposition synthesis of carbon nanotubes //Journal of Alloys and Compounds – 2015. –V. 621. – P.351-356.

2. Melezhyk A.V., Rukhov A.V., Tugolukov E.N., Tkachev A.G. Some aspects of carbon nanotubes technology / Nanosystems: physics, chemistry, mathematics. 2013, 4 (2), P. 247–259.

3. Nazhipkyzy M., Temirgaliyeva T., Zhaparova A.A., Nurgain A., Lesbayev B.T., Mansurov Z.A., Prikhodko N.G. Synthesis of Porous Carbon Material and Its Use for Growing Carbon Nanotubes// Materials Science Forum. –2017. –Vol. 886.– P.32-36.

4. Chunhua Li, Kefu Yao, Dianbo Ruan, Dehai Wu. Synthesis of carbon nanotubes with Ni/CNTs catalyst. Science in China Series E Technological Sciences, 2003. – 46(3):303-308.

5. El-Shazly M. Duraia, Burkitbaev M., Mohamedbakr H., Mansurov Z., Tokmolden S., Gary W. Beall. Growth of carbon nanotubes on diatomite. Vacuum, V.84, Issue 4, 2009, P. 464-468.

6. Hassan Alijani , Mostafa Hossein Beyki, Zahra Shariatinia, Mehrnoosh Bayat, Farzaneh Shemirani. A new approach for one step synthesis of magnetic carbon nanotubes/diatomite earth composite by chemical vapor deposition method: Application for removal of lead ions. Chemical Engineering Journal 253 (2014). P. 456–463.

7. Jorio A., Pimenta M.A., Souza A.G., Saito R., Dresselhaus G., Dresselhaus M.S. Characterizing carbon nanotube samples with resonance Raman scattering. New J Phys. 2003;5:139.1–17.

8. *Temirgaliyeva T.S., Nazhipkyzy M., Nurgain A., Mansurov Z.A., Bakenov Zh. B.* Synthesis of carbon nanotubes on shungite substrate and their use for lithium-sulfur batteries// Journal of Engineering Physics and Thermophisics. – 2018. – Vol. 91, № 5, P. 1365-1371.

9. Roberta A. DiLeo. Journal of Applied Physics. 101, 064307 (2007); doi: 10.1063/1.2712152.

10. CançadoL.G., JorioA., Martins FerreiraE.H., StavaleF., AcheteC.A., CapazR.B., MoutinhoV.O., LombardoA., KulmalaT.S., and FerrariA.C. Quantifying Defects in Graphene via Raman Spectroscopy at Different Excitation Energies. Nano Lett. 2011, 11, 3190–3196. doi:10.1021/nl201432g