INFLUENCE OF METEORITE STRUCTURE ON NANOTUBES AND NANOCRYSTALS SYNTHESIS

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Introduction: In this work, the carbon nanotubes (CNTs) and oxide nanocrystals synthesis on ther metal part of Seymchan (PMG) as a substrate are presented. CNTs were grown using chemical vapor deposition (CVD) technique, which requires the substrate containing nuclei for the formation of carbon structures. Commonly usable metals for that purpose are Fe, Co, Ni [1]. The aim of our work was to reveal an influence of structural composition [2] (Fe-Ni alloys) and etching treatment of meteorite surface on CNTs growth and morphology. Additionally, there is a hypothesis that periodic structures could be the cause of the formation of orderliness in organic compounds [3].

Materials and Methods: Sample of Seymchan was prepared using standard metallographic procedures: grinding, polishing, and etching with nital. Etching for 15, 10, 5, and 0 minutes to rich different surface structure was carried out. Structural composition of the sample was investigated using optical microscopy with Zeiss Axiovert 40 MAT. Then areas of analysis were marked, and the sample was observed using scanning electron microscopy (SEM) with Zeiss Sigma VP.

CVD process was performed using "CVDomna" commercial equipment for carbon nanotube growth. A vapor-gas mixture of ethanol and air was passed in the reaction chamber. The ethanol pyrolysis was carried out at the temperature of 600°C and the pressure of 15 kPa for 10 minutes. After the growing process the sample was cooled under ambient air. The synthesized structures on Seymchan surface was investigated using SEM and Raman spectroscopy. Results of Raman spectroscopy were obtained in UB RAS Common use center "Geoanalyst" with LabRam HR Evolution, the lateral resolution was 1-2 μm. The purity of CNTs can be defined as a content ratio of CNTs to impurities and was evaluated using Raman spectroscopy. The evaluation based on the G/D bands intensity ratio. The G-band around 1600 cm^{-1} is the tangential mode of CNTs and the D-band around 1350 cm^{-1} is sensitive to defects [4, 5].

Results: The Raman study of the sample shown, that surface is covered with oxide crystals (Fe_2O_3, NiO) and CNTs. Furthermore, CNT purity is higher if the amount of NiO is higher. SEM investigation revealed that prism-shaped oxide crystals constitute the nearest to the sample layer, and CNTs are the upper layer.

There is an effect of phase composition on a synthesized nanostructure. Rhabdites are covered by ribbons with an average width of 60 nm and CNTs with a diameter of 20 nm. Low aspect ratio CNTs with an average diameter of 30 nm cover schreibersite. The 15 nm diameter nanotubes were synthesized on taenite, plessite, kamacite surface. The greatest purity of CNTs was obtained on a tetrataenite surface. External boundaries of taenite bands are covered with perpendicular to these boundaries arrays of CNTs. A fine-grained plessite is covered with curved CNTs. Quantity of CNTs on a kamacite surface is approximately 5 times less than on taenite surface. Detailed information is presented in table 1.

Table 1 – Characteristics of synthesized nanostructures

Mineral substrate	Synthesized structures on the surface
Schreibersite	110 nm oxide crystals, low aspect ratio (approximately 30) CNTs with average diameters of 30 nm
Rhabdites	60 nm oxide crystals, 60 nm width ribbons, CNTs with average diameters of 20 nm
Taenite	50 nm oxide crystals, vertical arrays of diameter CNTs with average diameters of 15 nm
Plessite	50 nm oxide crystals, curved CNTs with average diameters of 15 nm
Kamacite	50 nm oxide crystals, curved CNTs with average diameters of 15 nm, quantity of CNTs is 5 times less than on taenite and plessite

In addition, the influence of etching time treatment of substrate on CNT growth is also detected. Longer etching time leads to obtain more CNTs on the surface. The sizes of oxide crystals after the CVD process correlate with an initial surface grain structure formed due to etching treatment of the sample.

Discussion: We suppose that during the CVD, oxide crystals were formed first, and these crystals were the nuclei for the CNT formation. Etching treatment increases a surface area which may undergo oxidation, so we obtained more oxide crystals and then more CNTs. The nickel concentration in the initial sample affects on CNT quantity and purity, the greater amount of nickel gives purer CNTs. Initial sample structure has an influence on CNT shape. Arrays of vertical CNTs were synthesized on bands borders, and curved CNTs were obtained on kamacite and plessite surfaces.

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