SYNCHESIS OF CARBON NANOTUBES ON THE CHINGA METEORITE

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Introduction: Iron meteorites contain a set of Fe-Ni alloys with various structure and Ni content. It is known [1], that these alloys can be appropriate substrate to grow carbon nanotubes (CNTs). This research is devoted to obtaining of carbon nanotubes and hematite nanowhiskers on the meteorite's surface. We used the Chinga ataxite. It contains the submicroscopic duplex plessite and kamacite spindles with enveloping taenite [2]. Thus we can see the influence of the various Fe-Ni alloys at on sample.

Materials and methods: The first sample was prepared using standard metallographic polishing and etching with 1 wt. % nital during 5 minutes. This led to the revealing of a submicron structure of the sample. Then several areas were marked on the sample and were analyzed before and after the synthesis of nanomaterials.

The nanomaterials were synthesized by a catalytic pyrolysis of ethanol using "CVDomna" commercial equipment for carbon nanotube growth. The sample was placed into a reaction chamber, then heated to 600°C at a pressure of 1 kPa. A vapor-gas mixture of ethanol and air was passed into the reaction chamber during 10 minutes at a linear increase in pressure to 15 kPa. The sample was cooled to 400°C at a pressure of 1 kPa and then cooled under an ambient air. The sample was studied by scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) using Zeiss Sigma VP.

Results: The deep etching have led to removing of the low-Ni layers from the plessite. The EDS showed that the total nickel content in the plessite area reached 35 wt. %. The Ni content of kamacite was ~7 wt. %. The Ni content of taenite rim was ~25 wt. %. After the catalytic pyrolysis the kamacite's surface was covered with rare hematite nanowhiskers with an average diameter of 15 nm. The surface of the taenite rim was covered with an array of vertical hematite nanowhiskers. We obtained CNTs (average diameter is 20 nm) as well as hematite nanowhiskers on the surface of the duplex plessite. The Fig. 1 shows the surface of duplex plessite after the etching (Fig. 1a) and after the synthesis (Fig. 1b).

Discussion: The formation of the hematite nanowhiskers during the thermal oxidation of iron under the 600 °C was shown by [3]. Here we discuss about the CNTs' formation. At first, we assumed that hematite nanowhiskers lead to the growth of CNTs under experimental conditions, but this was not confirmed experimentally. Furthemore, there was no CNTs on the taenite surface. The study of the plessite regions after etching at a higher magnification shows that in addition to the particles of the γ-phase with a size of 200x1000 nm, the sample contained smaller particles. During the synthesis ethanol decompose to CO and CO_2 [4]. These gases held in etched cavities. Thus, carbon receives enough submicroscopic Fe-Ni surfaces around it, which leads to the formation of CNTs.

References: [1] Kumar M. Y. and Ando Y. (2010) *Journal of Nanoscience and Nanotechnology* 10:3739-3758. [2] Buchwald V.F. (1975) *The Regents of the University of California* 1:115-124. [3] T. Vincent, M. Gross, H. Dotan et al. *International Journal of Hydrogen Energy* 37:8102-8109 (2012). [4] J. Gallego, G. Sierra, F. Mondragon et al. *Applied Catalysis A: General* 397: 73-81.

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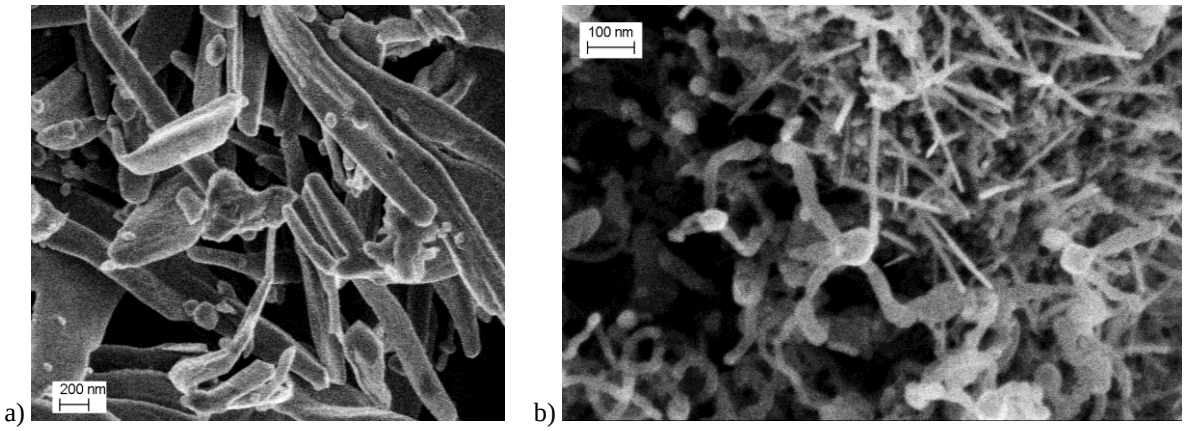

Fig. 1. The SEM images of plessite on the Chinga surface: **a) –** etched surface; **b) –** the CNTs on the left side and hematite nanowhiskers on the right side