INVESTIGATIONS INTO CATALYTIC ACTIVITY OF $LaNi_5$ IN SYNTHESIS OF CARBON NANOTUBES

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Introduction

Numerous methods of synthesis allows preparation of carbon nanotubes (CNT) of different purity and, consequently, with different properties. In particular, this is also related to their sorption properties. Data of different authors on CNT hydrogen capacity may differ by an order due to different conditions for synthesis. Conditions for sorption and hydrogen capacity especially depend on the state of hydrogen (at equal other conditions).

CNT saturation with activated hydrogen occurs under milder conditions.

Any of the hydride-forming metals or alloys may be used for hydrogen activation when its sorption-desorption thermodynamics satisfies the certain conditions.

However, reversible sorption capacity and chemical activity of all the hydride-forming materials greatly depend on the state of their surface. Electronegative impurities (O,N etc.) present on the surface result in deterioration in kinetics of hydrogen sorption. Penetration of impurities into the particle bulk decreases its capacity and leads to its decrepitation.

When particles of hydride-forming metal were covered with protective layers, sorption kinetics and other operating characteristics were deteriorated.

This work is aimed to verify the hypothesis on creation of the hydrogen penetrable, hydrogen-sorbing protective layer of nanostructural carbon on the surface of the hydride-forming particle.

Nanostructural carbon is supposed to be a barrier against electronegative impurities. Dynamic equilibrium of hydrogen sorption-desorption processes will allow the metal particle to be donor of activated hydrogen for nanostructural carbon.

Experimental

$LaNi_5$ ($MmNi_5$) intermetallide of AB_5 type was used as a metal hydride-froming component.

We have attempted to grow nanotubes on the intermetallide surface by two methods:

1. Catalytic pyrolysis of acetylene.
2. Electro-erosion sputtering of the alloy of AB_5 type in liquid hydrocarbon.

In the first case intermetallide was mixed with catalyst for CNT synthesis - Ni/Cu (98 wt.%/2 wt.%). The mixtures were prepared beginning from the proportion NiCu:$LaNi_5$ = 1:1. The concentration of $LaNi_5$ fraction was gradually increased by mixing in the ball mill in hydrogen at P=0.5 MPa.

Catalytic activity of the mixtures prepared has been investigated in regard to the CNT growth. The mixtures passed through the furnace for catalytic pyrolysis (the apparatus was designed in laboratory 67 in Institute for Problems of Material Science of National Academy of Sciences of Ukraine).

The electric sparc erosion apparatus was used in the second case. (The apparatus was also designed in laboratory 67 in Institute for Problems of Material Science of National Academy of Sciences of Ukraine). Hydrocarbons and their mixtures were used as sources of carbon.

Results and discussion

In the first case, in hydrocarbon pyrolysis, CNTs grow on all the mixtures up to the proportion NiCu:$LaNi_5$=2:98. At this proportion CNTs do not form on pure $LaNi_5$. Therefore, in spite of the fact that intermetallide contains a high amount of nickel, which is catalyst for CNTs growth, CNTs do not form in these experimental conditions.

In the second case, during electric arc $LaNi_5$ sputtering in the hydrocarbon medium, different carbon-hydrocarbon layers form on the surface of particles. CNTs (Fig.1), similar to those produced by this methos on pure nickel [1], have been found only on the particles prepared in solvent-2355.

Conclusions

In catalytic pyrolysis of hydrocarbons in the range from 800 to 1200 ^oC, $LaNi_5$ is not catalyst of the CNTs growth at the given experimental conditions.

However, during electric erosion sputtering of this alloy in hydrocarbons (of certain composition), CNTs may grow on the surface of $LaNi_5$ particles formed.

We can agree with this conclusion if we do not take into consideration the fact that intermetallide might be separated into components in the electric arc, and CNTs might grow on the particles enriched in nickel like in [1-23].

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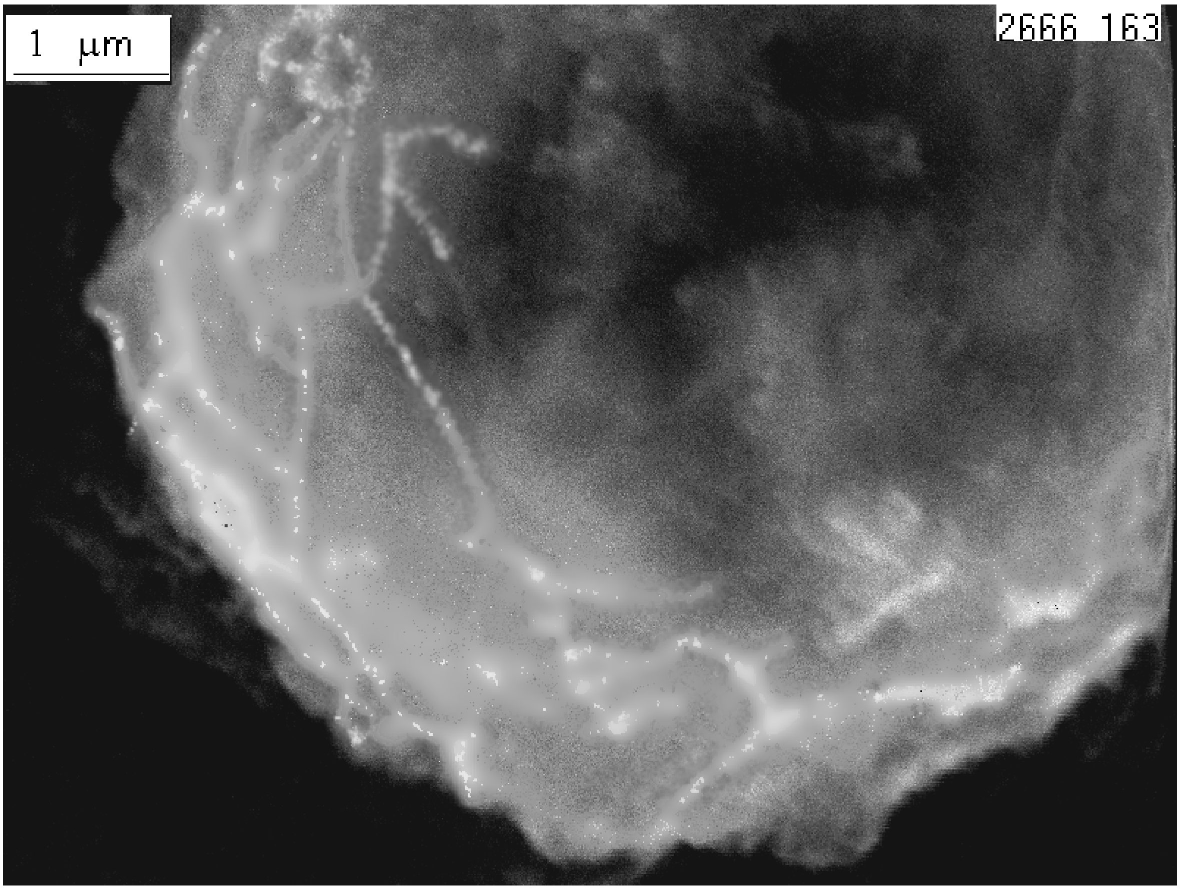

Fig. 1.

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