INVESTIGATION OF THE CONVECTION EFFECT ON PYROLYTIC SYNTHESIS OF CARBON NANOSTRUCTURES

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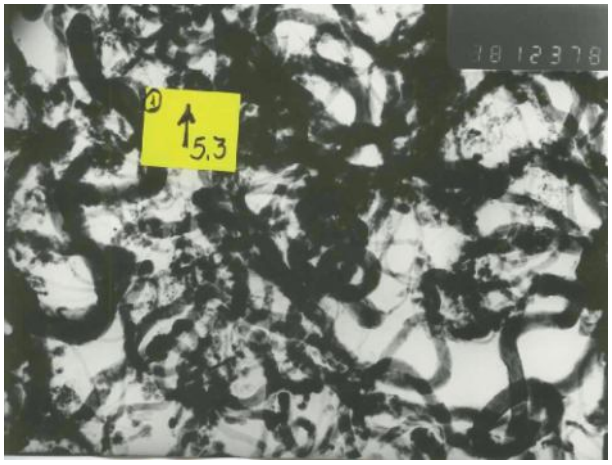
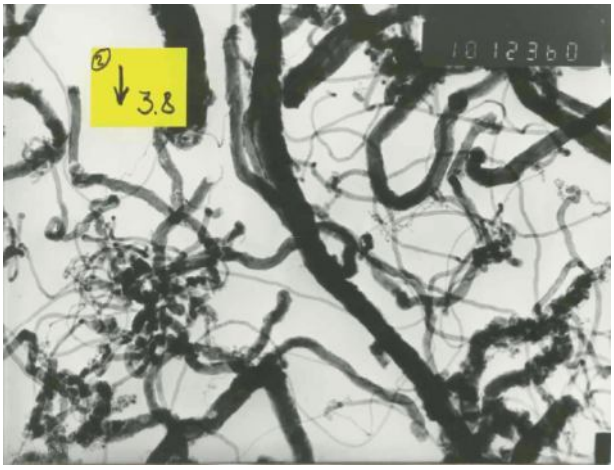
Introduction

The unique complex of mechanical and electrical properties of carbon nanotubes (CNT) may be used in composites when synthesized CNT or ropes from them are centimeters long. This work considers a possibility to synthesize carbon ropes having centimeters length and comprising CNT. Moreover, the effect of gas flows on morphology of the product formed has been investigated.

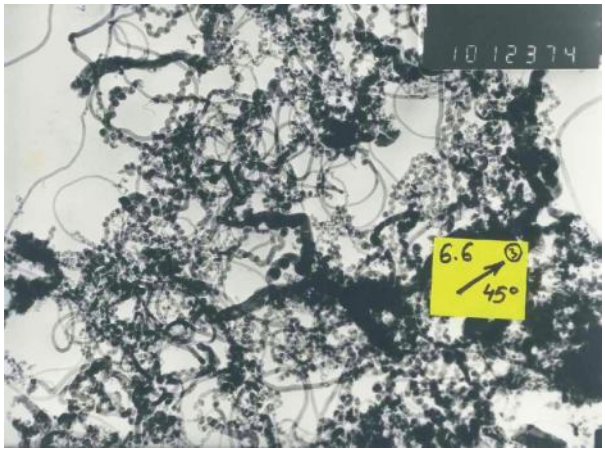
Fig. 1. Setup with vertical furnace.



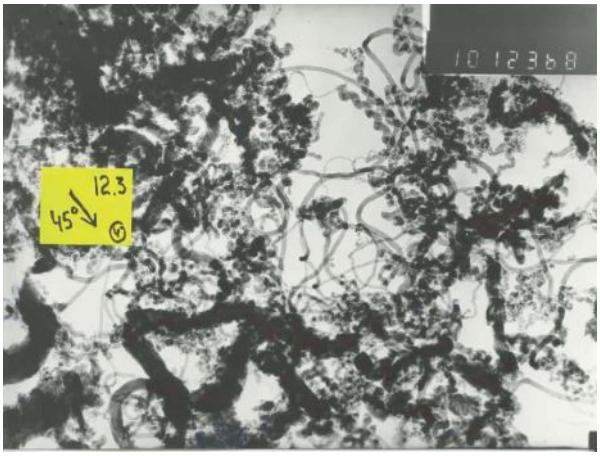
(a)



(b)



(c)



(d)

Fig. 2. Influence of motion of gaseous flow on the morphology and amount of formed product.

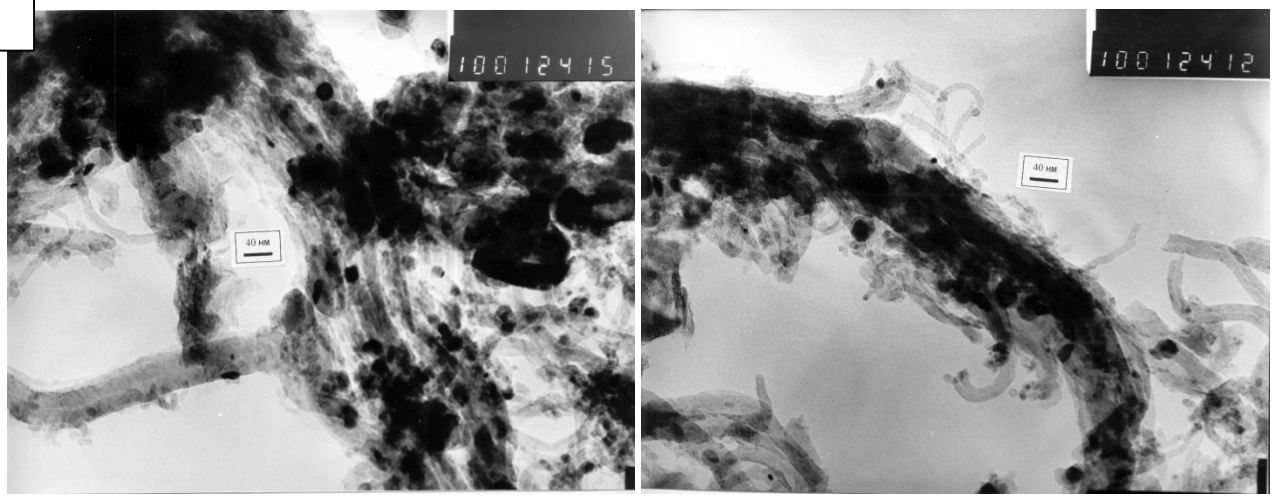


Fig. 3. Ropes from nanotubes produced in furnace with vertical reactor.

Experimental conditions

Based on our experimental data obtained during investigations into the effect of convective flows on distribution of nanostructural carbon products in the reactor for arc synthesis, and considering the fact that not only convection, but also gravitation and flows of reacting and waste gases affect the process of the product formation in the furnace with a vertical reactor, we have supposed to produce macrofibers that comprise bunches of nanotubes. The pyrolytic setup, which design allows the reactor to be positioned at any angle to horizon, has been manufactured for the investigations (Fig.1).

Acetylene or hydrocarbons vapors have been used as a carbon source. The process has been preformed in the quartz reactor on Ni-Cu catalyst in helium or nitrogen flow.

The synthesized products have been analyzed by transmission electron microscopy.

Results and discussion

The first experiments have shown that the direction of gas flow movement has a considerable effect on morphology of the product and its yield. When the working mixture is fed in the direction of the convective flow (Fig.2,a), the yield is twice as large as that opposite to the flow (Fig.2,b). In this case the yield is increased owing to the increasing geometrical dimensions of fibers.

When the reactor is positioned at 45^{o} to horizon, the effect is opposite. When the working mixture is fed opposite to the convective flow (Fig.2,d), the yield is increased twice with approximately the same geometry of fibers (Fig.2,c). The characteristic feature of the last two experiments is a high percentage of spiral fibers present in the product bulk.

Conclusions

We have succeeded to synthesize bunches of nanotubes that are united in fibers. However their length does not exceed 100 μm. As it is seen at large magnification, thick fibers comprise bunches of CNT (Fig. 3). However we have failed to prepare fibers centimeters long. Further investigations are required.