M.Sc. Tomasz Kaźmierczak

Promoter: prof. dr hab. inż. Piotr Niedzielski
Auxiliary Promoter: dr Witold kaczorowski

Faculty of Mechanical Engineering, Institute of Material Science and Engineering, Division of Biomedical Engineering Functional Materials, Lodz University of Technology

Mechanical modification of carbon powders manufactured using CVD methods enhanced with radio and microwave frequency plasma

Summary in English

Under the name of carbon powders there are many types and varieties and types of carbon structures, which can include nanotubes, fullerenes, diamond crystals, graphite and carbon in an amorphous form. This variety also involves a wide range of methods for the synthesis of carbon powders, among which one can mention low-pressure plasma techniques, as well as methods based on high temperatures and pressures, for example detonation for the production of nanodiamonds. The at the nano scale materials are still gaining more and more popularity, due to their unique properties not available for materials at the macro level. However, these properties are strongly dependent on the fineness of the material, its homogeneity and phase composition. These parameters can be modified at most stages of the production of carbon powder.

Obtaining carbon materials size of tens or hundreds of nanometers is possible at the stage of synthesis, as in the case of detonation powders, or during further modification. One of the leading roles in this field belongs to mechanical modifications, including milling. There are a number of types of mills, but mostly they are based on the phenomena of dynamic crushing and shearing of the material. It allows for the effective delivery of large amounts of energy to the material to be modified, which results in very high reduction in size. However, there is a risk of the introduction of changes, not only in morphology but also in the phase composition of the milled powder. There is therefore a need for selection of milling parameters to fully control both the particle size of the material obtained and its phase composition.

Based on a review of literature and conducted preliminary studies the following theses have been formulated:

- **It is possible to control the parameters of powders synthesis in order to obtain a continuous process**
- **It is possible to obtain through ball milling process carbon powders with uniform particle size.**
- **It is possible to limit the degree of graphitization of carbon powders during the ball milling by appropriate selection of the milling parameters.**

Following above theses formulated was the purpose of the work, which is:
" Determining the effect of synthesis and milling parameters of carbon powders on their physico-chemical properties."

The results obtained allowed to verify the formulated thesis and draw the following conclusions:

1. The carbon powders produced by plasma-assisted CVD process radio frequency and dual frequency (MW / RF) are fragments of broken carbon coatings.

2. More than two-hour synthesis processes limits the stability of operation of CVD by a short circuit between the electrode and a grounded working chamber caused by deposited carbon. Processes for producing carbon powders CVD can not be implemented continuously.

3. Production of homogeneous carbon powders CVD is only possible by using an additional milling process.

4. As a result of the milling process the purity of carbon powders decreases in correlation to the introduction of vessel or balls material of which it is made of.

5. By introducing liquid into the milling vessel the processes of graphitization of carbon powders can be reduced.

6. A combination of synthesis of carbon powders with milling in planetary ball mill creates the possibility of obtaining carbon powders of nanometric size with controlled physical and chemical properties.

T. Kaźmierczak

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