Method of obtaining by high-energy dry oscillatory mechanical grinding, on a large scale and at room temperatura, mesosporous material composed few sheetes of Graphene.

Description

This document details a new method for the production of nanomaterials based on graphene by means of which obtaining it in industrialized processes is affordable for entrepreneurs in the sector.

Graphene is a substance derived from graphite. The qualities of this element, transparency, resistance, weight, malleability, high electrical conductivity, electromagnetic wave absorption capacity, high reactivity, among others, give value and meaning to the large-scale production of this material.

How does it work?

The procedure comprises the following stages:

a) The process is carried out in an oscillating motion ball mill only from non-crystalline graphite in the form of flakes. This precursor is between 2 and 50 μm long and less than 100nm thick.

b) Precursor (graphite) is introduced into a metal container whose interior is coated with tungsten carbide to prevent contamination and/or the formation of unwanted phases.

c) A ball of tungsten carbide is added which has a volume ratio with the precursor graphite powder of approximately 1:1 and with the container container of approximately 1:50.

d) The container is closed and introduced into the mill enclaves to proceed with high-energy oscillating grinding.

e) The frequency must be between 15 and 30 Hz, preferably 225 Hz. These values imply oscillation frequencies of 1000 and 1500 rpm. The process is carried out under ambient temperature and pressure conditions.

f) To obtain homogeneous samples with high FLG quality, the grinding process time must be between 100 and 240 minutes. Pauses between 15 and 30 minutes are included to reach thermalization of material and the grinding equipment at room temperature and thus avoid unwanted increases in temperature inside the jars generated by friction during oscillating dry grinding. Otherwise, it could negatively affect the effective FLG exfoliation process and/or the generation of unwanted secondary phases.

Product obtained in powder form has structural properties typical of a few layers of graphene (FLG). FLGs have between 3 and 10 layers of graphene, are not oxidized by the grinding process, have structural defects and have electromagnetic absorption with a maximum around 260nm (ultraviolet region). All these properties are the basis of its application in various technological fields.

Advantages

1- In recent years, great commercial, scientific and technological interest has been generated in the production of two-dimensional materials such as graphene and graphene-based compounds (GBMs).

This method achieves the stacking of between 3 and 10 sheets of material, preserving certain properties of graphene reproducibly on a large scale by relatively simple and inexpensive physical processes.

2- Compared to the exfoliation of graphene layers by chemical means, where large amounts of high-purity material are obtained, but which have the disadvantage of involving a large number of chemical steps (some of them involving the spontaneous increase in temperature up to 1000C). In addition, solvents and strongly reducing and oxidizing agents are used. These are potentially dangerous and pose an added difficulty for production on an industrial scale.

3- Comparing it with wet mechanical grinding processes where solvents are used (sometimes combined with other additives), to assist the exfoliation process. In this case, a subsequent purification process would be necessary to separate the solid phase from the solvent.

Eliminating additives increases the complexity of the process, the materials used and, in some cases, these can compromise the characteristics of the final product. The material obtained would present flaws and changes in chemical properties.

Where has it been developed?

The large-scale production method of low-layer graphene (FLG) with a high degree of defects from graphite by high-energy dry oscillating ball milling is patented (ES2779151B2) by Complutense University of Madrid and has been developed at the Institute of Applied Magnetism. https://www.ucm.es/ima/

And moreover

Work is being done on the use of FGLs for NO_2 sensors with excellent results, as well as for absorbers of electromagnetic radiation and for supercapacitors. The results are promising and far superior to other materials. *(WO2022/008782 A1); (D. Matatagui et al. Seus. And Act. 335(15)129657(2021).*

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