Nanocomposites and nanomaterials

Exfoliated graphene manufactured by ultrasonic treatment

A.V. Yefanov[1], I.B. Yanchuk[1], V.O. Yukhymchuk[1], A.G.Rozhin[2]

[1] *V.Lashkarev Institute of Semiconductor Physics, Natl. Acad. of Sci. of Ukraine. Prospect Nauki, 41, Kiev-03029, Ukraine.*
E-mail: andriy.yefanov@gmail.com

[2] *Electronic Engineering Division, School of Engineering & Applied Science, Aston University, Aston Triangle, Birmingham, B4 7ET*

Most of the methods to obtain graphene are based on graphite intercalation [1], CVD epitaxy [2], graphitization of SiC at high temperature, etc. However, all of the above methods do not allow to obtain material with predetermined number of defects and their size, that is necessary to use graphene in producing nano- and optoelectronic devices. All this has led to search for efficient methods of obtaining graphene and graphene-based ultrathin films.

We used highly oriented pyrolytic graphite as a source material for producing graphene. Graphite was placed in an ultrasonic bath with N–methylpyrrolidone (NMP) solutions. To prepare the solution, 5 mg of graphite were dissolved in 20 ml of N-methylpyrrolidone. The solution was exposed to ultrasound with oscillation frequency of 21 kHz and power of 250 watts. Time of ultrasound treatment of graphite ranged from 30 minutes to 9 hours. As a result of such ultrasound treatment a colloidal solution with different mass of carbon nanoparticles was formed. The process of their separation by mass was carried out on a centrifuge during 30 minutes. Rotation speed of the centrifuge was $4 \cdot 10^4$ min^{-1}. The solutions of carbon nanostructures obtained by this method were deposited on glass substrates and then heated to 80°C in air for a few seconds. The obtained carbon films were investigated by Raman spectroscopy.

By varying time and power of ultrasonic treatment of pyrolytic graphite in N–methylpyrrolidone solution (NMP) we have managed to determine the optimum modes for production of graphene flakes.

1. *K.S. Novoselov, A.K. Geim, S.V. Morozov, et.al,* Electric Field Effect in Atomically Thin Carbon Films // Science.-2004.-**306**.-P. 666-669.
2. *C. Berger, Z. Song, X. Li, et.al,* Electronic confinement and coherence in patterned epitaxial graphene // Science.-2006.-**312.-**P 1191-1196.