Purification of single-wall carbon nanotubes by magnetic separation

O.A. Gurova[1]*, V.E. Arhipov[1], E.N. Vostretsova[2], V.O. Koroteev[1], O.V. Sedelnikova,[1] A.V. Okotrub[1]
[1]Nikolaev Institute of Inorganic Chemistry SB RAS, 3, Acad. Lavrentiev ave., Novosibirsk, 630090, Russia
[2] Tomsk State University, 36 Lenin ave., Tomsk, 634050, Russia
Corresponding author e-mail: olga.gurov@gmail.com

Carbon nanotubes have attractive optical, electronic, thermal and mechanical properties for various area of application [1]. However, one of the problems preventing useful application of CNTs is getting metal free nanotubes. The major impurities present in produced CNTs is metallic catalyst particles (e.g. iron, nickel, cobalt) remaining from the synthesis. The most common purification methods are the oxidation by different techniques [2], treatment with different acids [3], ultracentrifugation [4], etc.

In this work, we offer combination method of CNTs purification by HCl acid and magnetic separation. We use single-wall carbon nanotubes (SWCNT) provided by OCSiAl company. Tubes average diameter was 1.7 nm. SWCNT had a purity of 75%. According to atomic-absorption spectroscopy, the amount of Fe catalytic particles in the SWCNT data was ~ 7 mass%. In addition, TEM image confirms a large amount of Fe particles (fig. 1(a)).

In the first stage of purification, SWCNTs were treated with HCl acid in an ultrasonic bath. After HCl treatment, the amount of Fe decreased to 2%. SWCNTs dispersion containing surfactant was prepared for a second stage of purification. The SWCNT dispersion was passed through magnetic installation. The magnetic separation was carried out using silicone tube placed in a magnetic field. SWCNT dispersion was pumped by a slow flow through the tube. It was shown that the amount of iron is reduced to 0.3%. This method could be combined with other dispersion based techniques, which allow separation of SWCNT by transport properties and chirality.

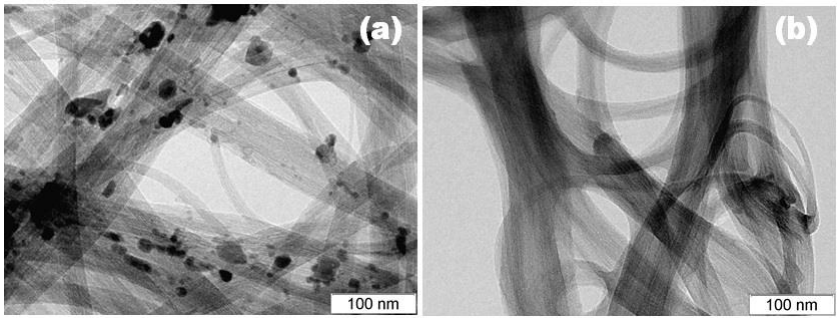

Fig.1 TEM images of (a) initial SWCNT and (b) after HCl treatment and magnetic separation.

This work was partially supported by and the Russian Science Foundation (Project 18-72-00017).

[1] J.G. Park, J. Louis, Q. Cheng, J. Bao, J. Smithyman, R. Liang, B. Wang, C. Zhang, J.S. Brooks, L. Kramer, P. Fanchasis and D. Dorough, Nanotechnology, **20**, 1 (2009).
[2] N. Dementev, S. Osswald, Yu. Gogotsi and E. Borguet, J. Mater. Chem., **19**, 7904 (2009).
[3] E.R. Edwards, E.F. Antunes, E.C. Botelho, M.R. Baldan and E.J. Corat, Appl. Surf. Sci., **258**, 2 (2011).
[4] Y. Matsuzawa, Y. Takada, T. Kodaira, H. Kihara, H. Kataura, and M.Yoshida, J. Phys. Chem. C, **118**, 9, (2014).