

## **XPS characterization onion-like carbon from nanodiamonds and carbon structure from onion-like carbon after high pressure high temperature treatment**

Skryleva E.A.\*, Shulga N.Yu.

*National University of Science and Technology «MISIS»,  
Leninsky prosp., 4, Moscow, 119049, Russia  
\*e-mail: 17sea@rambler.ru*

It is known, that heating nanodiamonds in a vacuum at temperatures of 1000-2000°C is an effective way to obtain onion-like carbon powder - laminated curved graphite-like shells. The transformations that occur with this form of carbon in the processing of high pressures high temperatures, HPHT, are poorly understood and are of interest

Synthesis onion-like carbon from nanodiamonds is accompanied by a transformation of  $sp^3$  type of hybridization to  $sp^2$  bonds with the formation of graphene layers from the surface into the volume the particle sequentially. HPHT type treatment should lead to closer of shells and the formation of  $sp^3$  bonds between them.

XPS allows to estimate the  $sp^2/sp^3$  ratio in carbon materials with mixing  $sp^2$  and  $sp^3$  bonds. The hybridization of carbon atoms was estimated from the photoelectron spectra of the C1s core level and its satellite resulting from losses for excitation of plasma oscillations of valence electrons, the  $\sigma + \pi$  plasmon.

The samples of carbon produced from nanodiamonds at temperatures 1000-1600°C were analysed by this method and it was shown that complete conversion into onion-like carbon is achieved at temperature above 1400°C. The samples of carbon produced at temperature 1600°C were processed at pressures 7.7 and 15 GPa at temperatures 500, 1350 and 1400°C. Interlayer  $sp^3$  carbon bonds were detected by XPS at temperature above 500°C.