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Positron spectroscopy of nanodiamonds after hydrogen treatment

L.V. Nikitina, R.S. Laptev, A.M. Lider, A.A. Mikhaylov

[1]*General Physics Department, Institute of Physics and Technology,Tomsk Polytechnic University, 634000 Tomsk, Russia*

e-mail: gulidova@tpu.ru

The carbon-based material was formed by detonation synthesis (FRPC "Altai", Byisk, Russia). Synthesis of nanodiamonds is carried out by detonation of solid explosives in an inert atmosphere. The purified material consists of carbon nanodiamonds and onion-like particles. Nanodiamond consists of a crystalline diamond core and nondiamond shell with functional groups on surface.

Hydrogen concentration was measured by Gas Reaction Controller complex (Advanced Materials Corporation, USA) at low temperature and a pressure of 0.6 MPa. The concentration-time sorption isotherms show the concentration of hydrogen absorbed by nanodiamonds.

Investigation of positron lifetime (PL) and Doppler broadening (DB) shift of annihilation line before and after hydrogenation was performed using the special complex. The samples were arranged in a so-called «sandwich» and mounted in a special sample-holder. PL and DB spectra were collected simultaneously. The positron source was represented by a ^{44}Ti isotope with an activity of 24.5 μCi.

Spectra were fitted using LT10 software. The spectral analysis was performed implementing a delayed formation of positronium (DFP) model. DB spectra were acquired by collecting 2.5×10^5 counts and analyzed using SP software package.

Table 1. The parameters of positron annihilation in the nanodiamonds before and after hydrogenation

Sample	$\tau_{o\text{-}Ps}$[ns]	$I_{o\text{-}Ps}$[%]	τ_T[ns]	I_T[%]	τ_{free}[ns]
Initial ND	3.05±0.04	3.35	0.51±0.01	14.8	0.30±0.03
Hydrogenated ND	2.35±0.04	5.07	0.42±0.01	42.3	0.29±0.02

The nanodiamonds hydrogen saturation leads to change the lifetime of trapped positrons and ortho-positronium, intensity, S and W-parameters.

Consequently, these results show that positron spectroscopy can be used to study carbon hydrogen storage materials.